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INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

[625 .162]

REPORT No. 4

(Italy, Spain and Portugal)

ON THE QUESTION OF LEVEL CROSSINGS (PUBLIC ROADS) (SUBJECT I-B, FOR DISCUSSION AT THE TENTH SESSION OF THE INTERNATIONAL RAILWAY CONGRESS ASSOCIATION) (¹),

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Figs. 1 to 25, p. 1625 to 1649.

We must, in the first place, express our regret that we have to report to the Congress that a considerable number of the administrations consulted have neither replied nor furnished the information for which they were asked; for this reason, in view of the importance of some of the railways in question, the report which we have been entrusted with drawing up is unfortunately incomplete and contains less information than one would have wished.

Of the thirty-six administrations consulted, only fifteen, that is 45 %, have replied.

Reckoning those which have replied and those which have not replied on a mileage basis, we find that the twenty-six administrations to whom the questionnaire was sent possessed in all 37 523 km. (23 316 miles) of track, of which 30 317 km. (18 838 miles), that is 80 %, belong to the fifteen administrations who have sent in the information asked for.

Of these fifteen administrations, eight have sent in complete and carefully drawn up reports, the other seven have informed us that in view of the special conditions prevailing on their line they have not been able to give any particulars of interest worth while including in our report.

The eight administrations who have

(¹) This question is worded : « Dispensing with crossing keepers. Visibility of the trains from the crossing : warning notices and signals, etc. »

(²) Translated from the French.

sent in useful data represent 26 785 km. (16 644 miles) of track, that is 71 % of the total length of the track owned by all the administrations consulted.

These eight administrations may be divided according to nationality, as follows: two Italians, four Spanish and two Portuguese.

We have grouped according to nationality abstracts of the replies received and have added a final summary and comments for each group, and these have then been compared one with another in order to obtain the final summary and deductions which we have the honour of laying before the Congress.

CHAPTER I.

Legal and administrative regulations.

QUESTION 1. — *Laws relating to the closing and protection of public level crossings.*

NOTE. — *If the legal regulations have been recently amended, give the actual texts as well as the original, also the date when the new regulations were put into force.*

Italian Administrations.

Italian State Railways. — ACT PASSED 20 MARCH 1865. — *Article 213.* — Public or private railways, including those worked by animal power, which cross public or private roads, must be provided on both sides by gates or similar devices which effectively prevent simultaneous crossing by a train or by persons, animals and vehicles using on the road.

Close to a level crossing there should be a gatekeeper's shelter provided with all the necessary means to ensure that the crossing is in good condition and that the ground is kept level so as to facilitate traffic passing over it.

ROYAL DECREE OF THE 31 OCTOBER 1873. — *Article 13.* — The crossing should be effectively closed and provided with movable gates situated at a suitable distance from the crossing. These gates to be of the type approved by the Government.

They shall be closed at least 5 minutes before the passing of a train. They shall also be kept closed when the level crossing is not in charge of gatekeeper employed exclusively for this purpose.

ACT OF THE 30 JUNE 1906. — *Article 10.* — Main lines which cross ordinary roads on the level must be provided with gates, barriers, or other means of effectively closing them, which may be operated on the spot or from a distance. Close to each crossing special turnstiles may be provided for the use of pedestrians.

Accommodation crossings must be provided with gates, the key of which may be kept by the owner who uses it at his own risk.

On secondary railways, it is only necessary to close level crossings when the road crossed carries a large and important traffic and when sufficient visibility of approaching trains cannot be obtained.

However, on main line railways the Minister of Public Works may authorise some level crossings being kept permanently open for the passage of trains, these being in the case of roads which are seldom used or which are private roads.

Level crossings not provided with gates must be provided with fixed notice boards, and the Minister of Public Works

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reserves the right to require their being closed for reasons of public safety.

Article 11. — The speed of trains may reach the maximum allowed in accordance with the condition of the line, the nature of the rolling stock and the available brake power.

In the case of lines on which level crossings are not effectively closed or when no gates are provided and at which it is not possible to prevent persons and animals gaining access to the lines, the speed should be limited in accordance with local conditions and should not exceed 60 km. (37 miles) an hour for trains fitted with continuous brakes, and 45 km. (28 miles) for non-fitted trains.

The same limitations apply to the case of level crossings which are permanently open.

On secondary railways, these speeds are reduced to 40 and 25 km. (25 and 15.5 miles) an hour respectively.

ACT OF THE 23 JULY 1914. — *Article 16.* — The railway administration is authorised to apply the Act of the 30 June 1906 as regards the crossing of level crossings and the provision of gatekeepers on lines on which the maximum daily traffic is ten ordinary trains, the speed of which is not greater than that laid down by the said Act.

ACT OF THE 27 NOVEMBER 1919. — *Article 1.* — The Minister of Transport is authorised to apply, by Ministerial Decree, to lines normally worked by the State, the provision of the Act of the 30 June 1906, as regards the closing of level crossings and the provision of gatekeepers on secondary lines.

DECREE-ACT OF THE 7 NOVEMBER 1920. — *Article 1.* — The State Railway Administration is authorised to leave open, without gatekeepers, both on main lines as well as on secondary lines with a small traffic, such level crossings as have on either side a sufficient visibility, taking into account the speed of the trains and the quantity of traffic on the road which is crossed.

These level crossings should be clearly marked by means of notice boards placed by the side of the ordinary road.

Article 2. — The railway administrations shall decide, in accordance with the importance of the crossing and the number of trains, the frequency with which level crossings shall be inspected, provided this shall not exceed three days.

Reggio-Emilia Railway.— Public Works Act of the 20 March 1865. Modified by a Ministerial Decree of the 10 March 1920.

Spanish Administrations.

Northern Railway of Spain. — The text of the Acts dealing with gatekeepers at public level crossings are as follows : The Railway Police Act of the 23 November 1877; regulation of the 8 September 1878, for putting of this Act into force, and the Safety Regulations passed 15 November 1883.

Requirements dealing with the closing and provision of gatekeepers at public level crossings are contained in articles 8 and 22 of the above mentioned Act, and also in articles 18 and 21; the first mentioned in paragraphs 2 and 4 of the regulation, dated the 8 September, as well as in articles 73 to 83 inclusive of the safety regulations.

Madrid, Saragossa and Alicante Railway. — The Acts dealing with the provision of gatekeepers at public level crossings are as follows : Railway Police Act of the 23 November 1877; regulation of the 8 September 1878, for putting this Act into force, and safety regulations passed on the 6 July 1888.

Requirements dealing with the closing and provision of gatekeepers at public level crossings are contained in articles 8 and 22 of the above mentioned Act, and also in articles 18 and 21; the first men-

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tioned in paragraphs 2 and 4 of the regulation, dated the 8 September, as well as in articles 51 to 59 inclusive of the safety regulations.

Andalusian Railways. — Regulations for supervision of the lines of the Andalusian Railway.

Lorca to Baza Railway. — Spanish Railway Police Act of the 23 November 1877 and regulation of the 8 September 1878.

Portuguese Administrations.

Portuguese Railway Company. — Articles 15, 37 and 38 of the regulations for staff employed in guarding the lines.

National Portuguese Railway Company. — Agreement between the State and the Company dated the 29 July 1885 and 30 June 1903 (article 13). These have not been amended.

QUESTION 2. — *Ministerial regulations.*

Italian Administrations.

Italian State Railways. — Provision is made by circulars issued by the State Railway Administration.

Reggio-Emilia Railway. — Passed by Royal Decree on the 31 October 1873.

The provisions of this Decree are well known.

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — The Railway Police Act and the regulations for its application already quoted.

One may also consider, as a ministerial regulation, that dealing with the safety and upkeep of the track, as soon as this has received Royal assent.

Andalusian Railways. — Act of the 23 November 1877 and regulations dated the 8 September 1878.

Portuguese Administrations.

National Portuguese Railway Company. — These have already been given.

QUESTION 3. — *Rules which apply to the public.*

Italian Administrations.

Italian State Railways. — Warning posts are placed at level crossings which are open and unguarded (figs. 1 to 5).

With the object of avoiding accidents when crossing railways, the speed of vehicles should be reduced when approaching a level crossing, and the driver should lead the first horse by hand.

On coming up to the crossing, he should look along the railway in both directions, in order to make sure that there is no train in view and that he cannot hear the noise of one approaching; he should then cross the railway without stopping.

One should not cross a level crossing on a double line immediately after one train has passed without making sure that there is not a train approaching from the other direction.

It is very imprudent to cross a level crossing when there is a train in view.

At night time, or in foggy weather, these precautions should be still more carefully observed, and in any case road users should not go to sleep on their vehicles.

These precautions should be observed, not only in the case of level crossings at which warning posts are placed at a distance, but also in the case where the warning posts are placed close at hand.

November 1921.

Reggio-Emilia Railway. — The preceding rules apply.

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Close to level crossing.

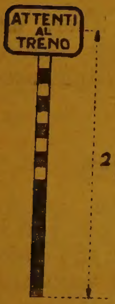

Fig. 1.

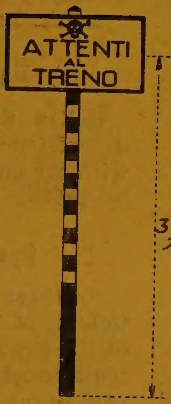

Fig. 2.

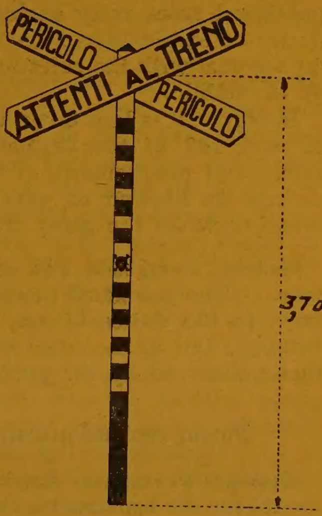

Fig. 3.

At 250 m. (820 feet) from level crossing.

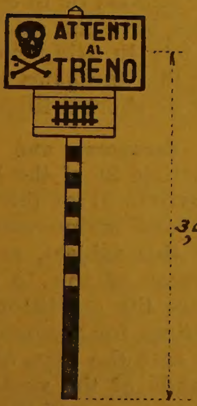

Fig. 4.

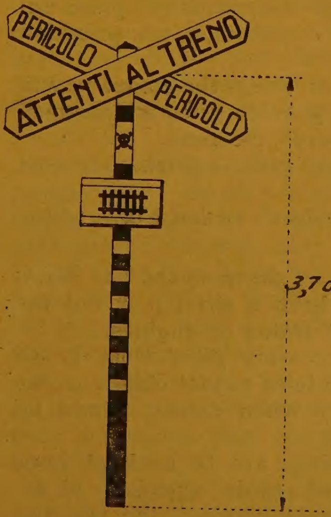

Fig. 5.

Spanish Administrations.

Northern Railway of Spain. — The published rules refer exclusively to the duties of employees of the railway, and do not deal with the rules to be observed by the public.

However, it is laid down in articles 74, 82 and 100 of the regulations for the safety and maintenance of the line, that no one is allowed to pass over a level crossing when the gates are closed.

Madrid, Saragossa and Alicante Railway. — The published rules refer exclusively to the duties of employees of the railway, and do not deal with the rules to be observed by the public.

Portuguese Administrations.

National Portuguese Railway Company. — Act for the construction and operation of the Santa Comba-Dao to Vizeu Railway, dated 29 July 1885.

Article 13. — Crossings of railways over first class and second class roads, local roads, etc., may be on the level, except where in the company's plans underbridges or overbridges are provided for.

At all these crossings the company will be obliged to provide gates which open outwards towards the road.

At each of the gates, a gatekeeper must be provided.

General Manager's Order, No. 7, of the 12 June 1889.

Article 3. — *Gatekeepers.* — Gatekeepers must keep a strict look out for the coming of trains or engines.

The level crossing gates must be so closed that vehicles cannot obtain access to the railway when danger would be caused thereby.

Level crossings are to be kept in a perfect state of repair, especially as regards the spaces between the running rail and guard rail.

Act for the construction and operation of the Mirandella to Braganza Railway, of the 24 May 1902.

Article 13. — Identical with the preceding.

Question 4. — *Contract forms (agreements, specifications, etc.).*

Italian Administrations.

Italian State Railways. — There are in existence typical agreements dealing with the guarding of level crossings used by private individuals.

Spanish Administrations.

Northern Railway of Spain. — Article 21 of the Railway Police Act, and 83 of the Act regarding the safety and maintenance of the railway, deal with this subject, as does also the Royal Decree of the 14 January 1897, which fixes the condition for guarding level crossings for accommodation roads, in which case the keys of the gates are in the hands of the parties concerned, without any responsibility being taken by the railway company in case of accident.

There are also special rules for certain level crossings which are much used at important stations or in their proximity. These rules have the object of ensuring greater safety in using the crossing and providing that the gates should be kept closed for as short a time as possible.

Madrid, Saragossa and Alicante Railway. — Article 21 of the Railway Police Act and article 51 of the Act regarding the safety and maintenance of the line, deal with this subject, as does also the Royal Decree of the 15 January 1897, which fixes the condition for guarding level crossings for accommodation roads, in which case the keys of the gates are in the hands of the parties concerned, without any responsibility being taken by the railway company in case of accident.

There are also special rules for certain level crossings which are much used at important stations or in their proximity. These rules have the object of ensuring greater safety in using the crossing and providing that the gates should be kept closed for as short a time as possible.

QUESTION 5. — *Number and definition of the various classes of public level crossings resulting from these regulations, either according to the density of the road traffic, the class of railway, or the number and speed of trains.*

Italian Administrations.

Italian State Railways. — The Administration of the State Railways have not classified the level crossings into categories from a railway standpoint. They are, however, classified in accordance with the importance and amount of traffic on the road crossed, that is as national, provincial, communal, local and private crossings.

Reggio-Emilia Railway. — See the following table.

Spanish Administrations.

Northern Railway of Spain. — Level crossings on this railway are classified in accordance with the importance of the traffic on the roads which they cross.

The recognised categories are as follows :

1° *Level crossings on national roads or where the traffic thereon is very great.*

A. — Where trains are run day and night, these level crossings are guarded by two gatekeepers, one by day and the other by night; they are open to public traffic both day and night.

If the importance of the road or the number of railway tracks crossed make it necessary, in addition to the two gatekeepers mentioned above, they are assisted in their duties during the day by women.

2° *Level crossings on fairly important local roads.*

B. — When trains are run during both day and night, these level crossings are guarded during the day, and are normally kept open except when trains are passing. During the night the gates are kept closed, but the gatekeeper who lives in a house close to the level crossing is obliged to open the gates when required.

Before doing so, she should make sure that the line may be crossed without danger.

When there are no trains during the night, the level crossing is kept open after the last train has passed until the first train of the following day.

In certain cases, where necessary in view of the importance of the road or the number of railway tracks crossed, the level crossing is guarded during the day by more than one employee.

3° *Unimportant level crossings.*

C. — When level crossings are unimportant and only used during harvest time, they are guarded during the day at this period, and left open at night. They are in charge of a male or female gatekeeper.

D. — When level crossings over unimportant roads are so situated that trains cannot be seen at more than 200 m. (220 yards) distance, they are guarded in the same way as in the case of local roads of a certain importance (*B*) and are provided with a gatekeeper's house and closed by chains.

E. — When these level crossings are so situated that the trains can be seen from a distance, they are neither closed nor guarded.

F. — When the level crossings are only used by a few pedestrians, they are neither closed nor guarded.

G. — Level crossings for pedestrians and pack animals are neither closed nor guarded.

H. — Level crossings for accommodation roads only used by one owner are neither closed nor guarded.

Madrid, Saragossa and Alicante Railway.

1° *Level crossings over main roads.*

A. — When there is a service of trains during the night, these level crossings are guarded by two gatekeepers, one by day and the other by night; the crossing is open for traffic all night.

If the importance of the level crossing renders it necessary there may be, at any rate during the hours when traffic is most intense on the railway and on the road, more than one gatekeeper so as to ensure that both the gates are properly operated at the same time.

2° *Level crossings over roads with an important traffic.*

B. — The same rules apply as for level crossings under category *A.*

3° *Level crossings over fairly important local roads.*

C. — During the day these level crossings are guarded, the gates being kept open and only being closed when a train is about to pass.

During the night they are kept closed, but the gatekeeper, either male or female, should live in a house built close to the level crossing, and is obliged to open the gates when required to do so should the running of the trains permit.

When there are no trains during the night, the level crossing remains open all night, without a gatekeeper, after the last train has passed until the passing of the first train on the following day.

4° *Unimportant level crossings.*

D. — If the level crossing is unimportant and only used to any extent during the harvest season, it is, during this period, guarded during the day and left open during the night; the gatekeeper may be either a male or a female.

If the level crossings are only used by a small number of land owners or farmers, they are neither closed nor guarded.

Level crossings provided for the particular use of one land owner are neither closed nor guarded by employees of the railway company.

Andalusian Railways. — The Government is investigating the question.

Lorca to Baza Railway. — The classification of level crossings into categories is under consideration.

Portuguese Administrations.

Portuguese Railway Company. — Public level crossings are classified into five categories which are defined in article 38 of the rules.

National Portuguese Railway Company. — 1st category : crossings over main roads; 2nd category : crossings over local roads; 3rd category : crossings over private roads.

CHAPTER II.

General particulars.

QUESTION 6. — *Number of public level crossings on the system, arranged according to their administrative classification : a) single lines; b) double lines; c) over two lines; totals.*

Italian Administrations.

Italian State Railways. — As has been mentioned in the answer to question No. 5, the State Railways have not classified the level crossings into categories from a railway point of view.

Reggio-Emilia Railway.

CATEGORY.	Level crossings.			
	a) single line.	*b*) double line.	*c*) more than two lines.	Totals.
1st category	5	4	...	9
2nd —	47	...	...	47
3rd —	117	...	...	117
Totals. . .	169	4	...	173

Spanish Administrations.

Northern Railway of Spain. — The number of level crossings classified into categories is as follows :

1° *Level crossings for single line.*

Category A : 402; B : 1 311; C : 462; D : 75; E : 342; F : 674; G : 37; H : 5; total : 3 308.

2° *Level crossings for double lines.*

Category A : ...; B : 233; C : 11; D : 4; E : ...; F : 36; G : 5; H : 1; total : 385.

3° *Level crossings for more than two lines.*

Category A : 44; B : 41; C : 16; D : 1; E: ...; F: 17; G: ...; H: ...; total: 119; total of 1°, 2° and 3°: 3 812.

Madrid, Saragossa and Alicante Railway. — The number of level crossings classified into categories is as follows :

CATEGORY.	Level crossings			
	a) single line.	*b*) double line.	*c*) more than two lines.	Totals.
1st category	89	39	20	148
2nd —	71	5	1	77
3rd —	1 138	203	35	1 376
Sundry unimportant crossings	949	124	4	1 077
Totals. . .	2 247	371	60	2 678

Andalusian Railways. — The number of level crossings classified into categories is as follows :

CATEGORY.	Level crossings.			
	a) single line	*b*) double line.	*c*) more than two lines.	Totals.
1st category	...	...	...	...
2nd —	...	...	...	...
3rd —	...	...	...	...
Sundry unimportant crossings	...	...	...	...
Totals. . .	1927(1)	23	...	1 950

Lorca to Baza Railway. — The number of level crossings classified into categories is as follows :

CATEGORY.	Level crossings.			
	a) single line.	*b*) double line.	*c*) more than two lines.	Totals.
1st category	...	...	...	...
2nd —	...	...	...	...
3rd —	...	...	...	...
Sundry unimportant crossings	...	...	...	...
Totals. . .	119	...	...	119

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(1) *Remarks.* — Whether guarded or not.

Portuguese Administrations.

Portuguese Railway Company.

Category.	Level crossings.		
	a) single line.	b) double line.	Totals.
1st category.	3	4	7
2nd —	50	78	128
3rd —	283	182	465
4th —	210	6	216
6th —	500	13	513
Totals. . .	1 046	283	1 329

National Portuguese Railway Company.

Category.	Level crossings single line.	Totals.
1st category.	26	26
2nd —	262	262
3rd —	158	158
Totals. . .	446	446

CHAPTER III.

Present regulations relating to public level crossings.

A. — Level crossings provided with gatekeepers.

a) SYSTEM OF GATE KEEPING. PARTICULARS.

QUESTION 7. — *State the various methods in use for protection purposes.*

Italian Administrations.

Italian State Railways.

Directly guarded by male or female gate keepers . . . { Permanently guarded during day and night; Guarded during day only.

Indirectly guarded by gates operated from a distance.

Reggio-Emilia Railway. — Gatekeeper who allows the public to pass over.

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — The gatekeeper may be stationed close to the crossing or at a distance, in accordance with whether or not his other duties have to be carried out close to the level crossing for which he is responsible.

On this railway, gates are only controlled otherwise than at the gate in the case of level crossings situated a short distance away from the signalbox which operates them.

One gatekeeper is only responsible for a number of crossings when these are very close together, when the gates are operated from a central control.

Andalusian Railways. — Level crossings are kept by gatekeepers, either male or female, who allow trains to pass by closing the gates or drawing chains across the road.

Lorca to Baza Railway. — The majority of level crossings on the lines of this company are guarded by means of a chain placed on each side; those which are situated in the proximity of stations in which shunting operations are being constantly carried out and a few level crossings over the very important roads are closed by means of gates.

Portuguese Administrations.

Portuguese Railway Company. — Regulations for the staff responsible for the safety of the line, dated the 1st January 1922 :

Article 38. — Barriers at level crossings. — Provision of gatekeepers and their principal duties :

1st category : Barriers which are constantly open during the day and night and are only closed when a train is passing.

A permanent gatekeeper is provided during the day and night, who is stationed close to the barrier.

2nd category : Barriers open during the day and only closed during the passing of trains; they are closed during the night except when users of the road require to cross the railway and the running of the trains allow this to be done.

A permanent gatekeeper is provided during the day and night, who is stationed close to the barrier.

During the night the gatekeeper should open the barrier to all vehicles wherever this can be done without danger.

3rd category : Barriers kept closed during the day by means of bolts; during the night they are fastened by padlocks.

During the day the gatekeeper has to remain close to the barrier, and during the night retires to his house, but is obliged to open the barrier during the day or night if required to do so by pedestrians or vehicles where this can be done without danger.

4th category : Barriers constantly open during the day or night and closed only during the passing of trains.

These are to be guarded during the day by a gatekeeper close to the barrier, who during the night retires to his house.

When trains are about to pass, he will close the barriers, which are not to be opened to the public until it is again safe to do so.

5th category : Barriers which are kept closed with padlocks, the keys of which are held by the property owners to whom the exclusive use of the level crossing has been conceded.

The owner signs a document accepting responsibility for anything which may happen at the level crossing.

In case of refusal on the part of the land owner to sign this document, the barriers are fastened by means of padlocks and the keys kept by the ganger in charge of the section. If the owner attempts to oppose this measure, the barriers will be forcibly closed, and a report sent in to the proper authorities.

6th category : Level crossings which are not guarded :

At these level crossings, pedestrians or vehicles wishing to cross the railway should very carefully satisfy themselves that no train is in view or signalled from either direction.

QUESTION 8. — *Classification of public level crossings used by vehicular traffic according to the method of their supervision as per table herewith.*

NOTE : *If the level crossings are only used by pedestrians, but are in charge of gate-keepers, this should be so stated in the tables.*

Italian Administrations.

Italian State Railways.

Total number of guarded level crossings		6 779
as follows :		
guarded by gatekeepers belonging to the Way and Works Department.	by day and night	3 665
	by day only	614
guarded by gatekeepers belonging to the Traffic Department		1 095
guarded by barriers operated from a distance		1 405

QUESTION 8. — **Grouping of level crossings used by vehicles according to the method of supervision.**

					Number of level crossings.
Level crossings guarded day and night or guarded during the day and closed at night time.			day and night	by an attendant with fixed post and not permitted to leave the barriers or gates.	......
	Normally open during the day time. Normally closed during the night time.	At barriers worked on the spot.	by day	by an attendant with fixed post	......
			by night	by an attendant who sleeps in the watchman's hut	......
			by day	by an attendant who may leave the barriers or gates, and rest in the watchman's hut	......
			by night	by an attendant who sleeps in the watchman's hut	......
		At barriers worked from a distance.	by night	by an attendant who sleeps in the watchman's hut	......
	Normally closed during the day time. Normally closed during the night time.	At barriers worked on the spot.	by day	by an attendant allowed to leave the barriers or gates and remain in the watchman's hut.	......
			by night	by an attendant who sleeps in the watchman's hut	......
		At barriers worked from a distance.	by night	by an attendant who sleeps in the watchman's hut.	......
Level crossings guarded by day and open at night, and without a keeper during the time the running of trains is suspended.	Normally open during the day time.	At barriers worked on the spot.	by night	by an attendant with fixed post	......
			by night	by an attendant who may leave the barriers or gates and remain in the watchman's hut	......
		At barriers worked from a distance.	by night	by an attendant who may leave the barriers or gates and remain in the watchman's hut	......
	Normally closed during the day time.	At barriers worked on the spot.	by night	by an attendant who may leave the barriers or gates and remain in the watchman's hut	......
		At barriers worked from a distance.	by night	by an attendant who may leave the barriers or gates and remain in the watchman's hut	......
				Total.	...... (1)

(1) Including those which the public are forbidden to pass over during a part of the day or year by application of article ..... in Regulations of the ......

During the hours when the line is open to traffic, these gatekeepers are continually on duty, and therefore it is unnecessary to tabulate the information asked for in question No. 8.

Reggio-Emilia Railway. — All level crossings are guarded. Total : 108.

Spanish Administrations.

Northern Railway of Spain. — Number of level crossings : *a*) 581, *b*) 297, *d*) 1 582, *f*) 32, *g*) 253, *j*) 8, *k*) 157, *o*) 2 972.

Madrid, Saragossa and Alicante Railway. — Number of level crossings : *d*) 1 742, *f*) 144, *k*) 153, *o*) 2 039.

Andalusian Railways. — Number of level crossings : *d*) 1 234, *o*) 1 234.

Lorca to Baza Railway. — Number of level crossings : *k*) 119, *o*) 119.

Portuguese Administrations.

Portuguese Railway Company.

1st category : Guarded by 3 men.	—	7
2nd category : Guarded by 2 men.	10	—
2nd category : Guarded by 1 man and 1 woman.	8	—
2nd category : Guarded by 2 women.	110	128
3rd category : Guarded by 1 woman.	—	465
4th category : Guarded by 1 woman.	—	216
Total.		816

National Portuguese Railway Company. — 1st category, 24 guarded; 2 not guarded; 2nd category : 13 guarded, 249 not guarded; 3rd category : 158 not guarded.

QUESTION 9. — *Total number of gatekeepers : men, women;* total.

Italian Administrations.

Italian State Railways. — Total number of gatekeepers : men, 4 081; women, 2 947; total, 7 028.

In this number are not included about 1 600 employees (watchmen and block system operators) who are only occupied during part of their time in guarding a level crossing.

In this connection we may also note that the total number of gatekeepers given refer to the regulations now in force as regards the eight-hour day of these gatekeepers, but their number will be decreased by the application of a later law which allows their day to be increased up to 9, 10, 11 or even 12 hours out of the 24. (Circular issued by the Direction of the State Railway, of the 20 October 1923.)

Article 1. — Gatekeepers. — Their working day is fixed at 12 hours, which may be between the following times :

5.0 a. m. and 9.0 p. m. from April to September;

6.0 a. m. and 7.0 p. m. for the other months, when the level crossing is within 50 m. (55 yards) of the gatekeeper's house;

or between 5.0 a. m. and 7.0 p. m. from April to September inclusive;

6.0 a. m. and 6.0 p. m. during the months of March and October;

7.0 a. m. and 5.0 p. m. from November to February inclusive when the level crossing is situated 50 m. or more from the gatekeeper's house.

Reggio-Emilia Railway. — Total number of gatekeepers : men, 1; women, 49; total, 50.

Spanish Administrations.

Northern Railway of Spain. — The total number of gatekeepers is as follows :

Men	498
Women	2 616
Total	3 114

Madrid, Saragossa and Alicante Railway. — The total number of gatekeepers of both sexes is 2 171.

Andalusian Railways. — The total number of gatekeepers is as follows :

Men,	47+ 10(Southern).	57
Women,	877+356.	1 233
Total,	924+366.	1 290

Lorca to Baza Railway. — The total number of gatekeepers is as follows :

Men	22
Women	97
Total	119

Portuguese Administrations.

Portuguese Railway Company. — Men, 50; women, 909; total, 959.

National Portuguese Railway Company. — Men, 0; women, 37; total, 37

QUESTION 10. — *Total length of lines belonging to the system.*

Division of this length into the various classes of lines (main lines, secondary lines, etc.), in cases where the level crossings are controlled according to the classification of the line.

Average number of gatekeepers (men and women) per kilometre of each class of line.

Italian Administrations.

Italian State Railways. — Total length of system : 14 600 km. (9 072 miles).

(The regulations in force at the level crossings do not depend on the category of the line.)

Average number of gatekeepers : 0.47 per km. (0.75 per mile) of line.

Reggio - Emilia Railway. — 71 km. (44 miles). No categories; 0.7 per kilometre (1.12 per mile).

Spanish Administrations.

Northern Railway of Spain. — The total length of the lines operated by the Company is 3 719 km. (2 311 miles), plus 40 km. (25 miles) now under construction from Zuera to Turunana; making a total of 3 759 (2 336 miles).

On the different lines, there are 535 km. (332 miles) of double track, including 424 km. (263 miles) of the line from Madrid to Irun; 56 km. (35 miles) of the line from Barcelona to Saragossa and 55 km. (34.1 miles) of the line from Palencia to La Corogne. There is also, in an advanced stage of construction, 116 km. (71 miles) which includes the loop line from Robledo to Avila (on the Madrid to Irun line) and from Palencia to Calzada (on the Palencia to La Corogne line).

All the lines are of the same category as regards the classification of the level crossings which, as we have seen above, is determined rather by the importance and amount of traffic on the ordinary roads which are crossed.

The average number of gatekeepers per kilometre is 0.8373 (1.347 per mile).

Madrid, Saragossa and Alicante Railway. — The total length of the lines of this railway is 3 663 km. (2 276 miles), of which 327 km. (203 miles) is double track.

These are not classified in accordance with their importance; the level crossings being classified in accordance with the importance of the traffic on the roads which are crossed.

The average number of gatekeepers per kilometre is 0.59 (0.95 per mile).

Andalusian Railways. — 1 692 km. (1 051 miles), average number of gatekeepers per kilometre is 0.76 (1.22 per mile).

Lorca to Baza Railway. — 168 km. (104 miles), 0.71 gatekeeper per kilometre (1.14 per mile).

Portuguese Administrations.

Portuguese Railway Company. — Total length of lines: 1 145.038 km. (711 miles), gatekeepers 0.83 per kilometre (1.34 per mile).

National Portuguese Railway Company. — 185 km. (115 miles) — 0.2 gatekeeper per kilometre (0.32 per mile).

QUESTION 11. — *Rules relating to the work of gatekeepers.*

b) *Devices or warning posts used to announce to users of the road the approach to a level crossing.*

Italian Administrations.

Italian State Railways. — Circular issued by the State Railway Direction, of the 20 October 1923.

Article 1. —The working hours of gatekeepers is fixed at 12, which shall be between the following times :

5.0 a. m. and 9.0 p. m. from April to September;

6.0 a. m. and 7.0 p. m. for other months when the level crossing is within 50 m. (55 yards) of the gatekeepers's house;

or between 5.0 a. m. and 7.0 p. m. from April to September inclusive;

6.0 a. m. and 6.0 p. m. during the months of March and October;

7.0 a. m. and 5.0 p. m. from November to February inclusive when the level crossing is situated 50 m. or more from the gatekeeper's house.

Reggio-Emilia Railway. — To open and close the gates.

b) None.

Spanish Administrations.

Northern Railway of Spain. — These are laid down by articles 84, 85 and 86 of the regulations for the safety and maintenance of the line.

Madrid, Saragossa and Alicante Railway.— These are laid down by articles 51 to 60 of the regulations for the safety and maintenance of the line.

Andalusian Railways. — From sun rise to sun set.

Lorca to Baza Railway. — The same as for the other Spanish railway companies.

Portuguese Administrations.

National Portuguese Railway Company. — 1st category : 8 hours per day; 2nd category : 12 hours per day; 3rd category : during the day : 4th category : whenever trains are passing during the day or night.

QUESTION 12. — *Number of roads crossing the railway on the level and fitted with warning posts or devices indicating the approach to a level crossing : in one direction, in two directions, in more than two directions.*

Italian Administrations.

Italian State Railways. — The State Railway Administration is not obliged to place and does not place warning apparatus or notice boards to notify road users that they are approaching level crossings which are guarded.

However, the « Italian Touring Club » Association undertakes the provision of the international signal at the approach of guarded level crossings which occur under certain conditions.

Reggio-Emilia Railway. — None.

Spanish Administrations.

Northern Railway of Spain. — As regards the provision made by the railway company, there are only apparatus which give warning when a level crossing is closed by means of audible signals, and these are only provided for crossings of certain categories.

On main roads and local roads there are warning posts placed on either side of the level crossing at a distance of about 650 feet therefrom. These posts are erected by the « Royal Automobile Club » and by the Public Works Department in the various provinces, or by the Consul Generals in the Basque provinces.

Madrid, Saragossa and Alicante Railway. — The company does not itself provide any warning of a visible nature. There are however audible signals provided at a few of the more important level crossings.

For main roads and local roads of certain importance, there are warning posts on both sides of the level crossing at about 650 feet therefrom. These posts are erected in some provinces by the « Royal Automobile Club » or by the Public Works Department.

Andalusian Railways. — No warning posts are provided.

In many cases warning posts are placed on the road, but these are not provided by the railway company.

Lorca to Baza Railway. — No warning is given of the approach to a level crossing.

Portuguese Administrations.

Portuguese Railway Company. — Posts with a board carrying the device of the « Automobile Club » (International type) are placed at 820 feet from the level crossing on either side.

In both directions : 187.

National Portuguese Railway Company. — Three warning posts.

Question 13. — *Conditions which determine whether it is necessary to give warning or not.*

Italian Administrations.

Italian State Railways. — See answer to question 12 .

Spanish Administrations.

Northern Railway of Spain. — The factors which determine the necessity of indicating the approach to a level crossing are as follows : conditions as regards its lay-out and the speed of the traffic concerned.

As we have said above, notice boards are only provided on main roads, and in these cases are maintained by the Public Works Department or by the Consul Generals in the Basque provinces.

Madrid, Saragossa and Alicante Railway. — The factors which determine the necessity of indicating the approach to a level crossing are as follows : conditions as regards its lay-out and the speed of the traffic concerned.

As we said above, notice boards are only provided on main roads and are maintained by the Public Works Department.

Lorca to Baza Railway. — There are no warning posts to indicate the approach to a level crossing.

Portuguese Administrations.

Portuguese Railway Company. — The importance and amount of traffic on the road.

Question 14. — *A critical and concise description of the various warning methods in use.*

Italian Administrations.

Italian State Railways. — See answer to question 12.

Spanish Administrations.

Northern Railway of Spain. — There are two systems on the lines of this company.

One consists of providing at the level crossing two « Siemens » bells operated by means of an electric contact controlled by two permanent way watchmen placed at a distance on either side of the level crossing at which the apparatus is provided. As a train passes one of these men, he closes the electric contact, which causes the bell to sound, thus warning the gatekeeper, who should stop the traffic on the road and inform the public that they must not cross the railway.

This system, although excellent in principle, as it does not interrupt traffic at a crossing except for the length of time absolutely necessary for a train to pass, has, however, the serious defect inherent to all signals which are operated electrically, for if there is an interruption by any reason of the current or any fault in the transmission apparatus no warning of the approach of a train is given at the level crossing.

The present system for level crossings at which the barriers are operated from a distance consists of giving warning by means of an electric bell when these are closed. This bell continues to sound during the whole time that the gates are closed.

As regards notice boards placed close to a level crossing, we may refer to those already mentioned which exist on the roads which cross the company's lines and which are erected by the « Royal Automobile Club » and by the Public Works Department or Basque authorities.

They consist of a wooden post which carries at the top a board on which is painted a gate. These warning posts are placed at the side of the road at a distance of 1 640 feet on either side of the level crossing. Their principal defect is that they are not illuminated at night.

Madrid, Saragossa and Alicante Railway. — The present system for level crossings at which the barriers are operated from a distance consists of giving warning by means of an electric bell when these are closed. This bell continues to sound during the whole time that the gates are closed.

As regards notice boards placed close to a level crossing, we may refer to those already mentioned which exist on the roads which cross the company's lines and which are erected by the « Royal Automobile Club » and the Public Works Department.

They consist of a wooden post which carries at the top a board on which is painted a gate. These warning posts are placed at the side of the road at a distance of 650 feet on either side of the level crossing. Their principal defect is that they are not illuminated at night.

Andalusian Railways. — Only one post provided with an arm.

Lorca to Baza Railway. — No warning posts are provided for giving warning of the approach to a level crossing.

QUESTION 15. — *Who defrays the expense of warning?*

Italian Administrations.

Italian State Railways. — The cost of providing the international signals mentioned in answer to question 12 is borne by the « Italian Touring Club ».

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — The audible signals are erected at the cost of the railway company, and the visible signals at the cost of the authorities who erect them on the road side.

Lorca to Baza Railway. — No warning posts are provided for giving warning of the approach to a level crossing.

QUESTION 16. — *Are gates painted in a special manner, or supplied with distinctive signs to make them more visible ?*

Italian Administrations.

Italian State Railways. — Yes; the barriers are painted with black and white stripes in order to render them more visible.

Reggio-Emilia Railway. — No.

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — The majority of the barriers are painted grey in order to preserve the metal.

The majority of unimportant level crossings are closed by means of chains.

Andalusian Railways. — When the barriers take the form of gates, these are painted black and white.

Lorca to Baza Railway. — The level crossing gates where these are provided are painted white with a red disc in the middle about 0.7 m. (2 ft. 3 1/2 in.) diameter.

Portuguese Administrations.

Portuguese Railway Company. — The barriers are painted red with a diagonal of sheet iron painted white.

QUESTION 17. — *Under what conditions are level crossings lighted. Statistical particulars relating to this subject.*

Italian Administrations.

Italian State Railways. — Level crossings are not lighted.

Whether they are guarded or not does not depend upon the category of the line but upon the visibility of the level crossing.

Reggio-Emilia Railway. — By oil lamps.

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa & Alicante Railway. — The level crossings are not lighted by the railway company, except where these are situated at a place where lights are provided for other purposes.

Andalusian Railways. — The gatekeeper has a lantern.

Lorca to Baza Railway. — By lamps which shew a red or green light, according to whether the level crossing is closed or open. Level crossings which are closed by means of a chain are provided with hand lanterns.

B. — Unprotected level crossings.

a) RULES AND PARTICULARS.

QUESTION 18. — *Number of unprotected level crossings : 1° since they were first established; 2° those where protection has been dispensed with since they were put into operation; 3° total.*

> NOTE. — *If gatekeeping depends on the class of line (main line, secondary line, etc.), state how many for each class are supplied with keepers.*

Italian Administrations.

Italian State Railways. — 1° 970; 2° 5 598; 3° 6 568.

Reggio-Emilia Railway. — 1° 65; 2° 46 and 3° 19 which were abolished by the Act of the 10 March 1920.

Spanish Administrations.

Northern Railway of Spain. — The number of level crossings which are not guarded on the lines of this company is 1 247.

Madrid, Saragossa and Alicante Railway. — The number of level crossings which are not guarded is 840, and this has been the state of all of these since the time they were constructed and not as the result of an alteration in the laws authorised by the Government.

Andalusian Railways. — The number of level crossings which are not guarded is 716.

There is no classification.

Lorca to Baza Railway. — There are none.

Portuguese Administrations.

Portuguese Railway Company. — Number of level crossings which have never had gatekeepers, 603; number at which gatekeepers have been subsequently done away with, 10; total, 613.

QUESTION 19. — *State why gatekeepers have been dispensed with.*

Italian Administrations.

Italian State Railways. — To reduce the staff.

Reggio-Emilia Railway. — By the Ministerial Decree.

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — Gatekeepers have not been abolished at any level crossings since the line was first operated.

Portuguese Administrations.

Portuguese Railway Company. — Reduced traffic on the road.

QUESTION 20. — *Administrative reasons and actual conditions (visibility, number and speed of trains, features of the road, etc.), which have made it possible to have unprotected crossings.*

Italian Administrations.

Italian State Railways. — Level crossings are left open and unguarded at any place on the line, whatever the speed of the trains, provided they have the visibility as laid down in the following instructions :

In order that a level crossing may be left permanently open without a gatekeeper, it is necessary that the railway should be visible on both sides of the level crossing, at least for a distance L as determined by the following formula :

$L = l\frac{V}{2}$, l being as a minimum, the length of the crossing measured along the axis of the ordinary road, and as a maximum, the length of the longest road vehicle in use in the locality increased by that of the teams used for hauling the heaviest vehicles which use the road;

V is the maximum speed of the lightest trains which run on the railway.

(It is supposed that the speed of pedestrians and road vehicles is 2 km. [1.2 miles] per hour).

When the railway on either side of the level crossing is on a falling gradient of 1 in 200 or more, the visibility distance of the line should be increased by 20 %.

(Circular of the 30 December 1920.)

Reggio-Emilia Railway. — For reasons of economy, provided that it is not on a curve or on a falling gradient greater than 1 in 200.

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — Non-guarded level crossings are only used for footpaths or roads on which the traffic is very light, or for occupation crossings.

For this reason no information has been sent in on this question in reply to the questions asked by the reporter.

QUESTION 21. — *Administrative reasons and actual conditions (visibility, number and speed of trains, features of the road, etc., or various improvements which have permitted gatekeeping to be dispensed with.*

Italian Administrations.

Italian State Railways. — Legal arrangements are given in the first Circular issued by the Administration (30 December 1920), which deals with the cutting of hedges, trimming and cutting trees, deviation of roads, demolishion of walls, purchase of small pieces of land near the railway, etc.

Reggio-Emilia Railway. — None.

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — As has been said above, level crossing gatekeepers have not been dispensed with since the lines were first opened for traffic.

QUESTION 22. — *If abolition of gatekeeping has been possible on account of the reciprocal visibility from the railway and the road in the vicinity of the level crossing, what measures have been taken to safeguard the visibility after the gatekeepers have been dispensed with.*

Italian Administrations.

Italian State Railways. — Hedges are cut short; trees are trimmed or cut down, and owners are compelled by law to prevent them from encroaching beyond their proper limits.

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — No level crossing gatekeepers have been abolished in this way.

b) WARNING DEVICES FIXED ON THE ROADWAY ANNOUNCING TO PASSERS-BY THAT THEY ARE APPROACHING A LEVEL CROSSING OR THAT A TRAIN IS ARRIVING.

QUESTION 23. — *Is it obligatory to fix warning devices to announce to users of the road that they are approaching a level crossing ?*

Italian Administrations.

Italian State Railways. — Yes, the appoach to unguarded level crossings is notified to road users by warning posts.

These warning posts, placed as a rule on both sides of the level crossing, are supplemented by a second post erected at the cost of the railway company, which carries the Touring Club sign in the case of a road much used by motor traffic.

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — There is no regulation in existence rendering obligatory the use of these devices, and the company has no level crossing provided with signals which is not guarded.

Andalusian Railways. — We have none.

Lorca to Baza Railway. — None in existence.

QUESTION 24. — *What are the warning devices used for this purpose, either by day or by night.*

Italian Administrations.

Italian State Railways. — Diagrams of warning posts are given in figures 9 and 10.

TYPE *a* (figs. 6 to 8): Warning posts placed in the proximity of unimportant level crossings.

They are made entirely of wood, although occasionally old rails are used for the post.

TYPE *b* (figs. 9 and 10): Warning posts placed in the proximity of important level crossings.

They may also be made entirely of wood or by using old rails. They may also be made of reinforced concrete, in accordance with the details given in figures 11 to 15.

TYPES *c* and *d* (figs. 16 and 17): For very important level crossings, these are placed on each side of the crossing, and other warning posts are provided at 820 feet distance which are a repetition of the warning posts placed close to the crossing. These also carry the international warning sign of the « Touring Club ».

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — Level crossings which are not guarded are not provided with any warning apparatus in their proximity or devices giving warning of the approach of trains, as the traffic over the roads concerned is very slow on account of their unmetalled surface.

Lorca to Baza Railway. — There are none.

QUESTION 25. — *Give a short and complete description of these devices:*

Do they indicate the number of lines to be crossed ?

Are crossings supplied with advance signals ?

At what distance are the latter fixed from the crossings ?

Italian Administrations.

Italian State Railways. — No.

Yes, as said in the answer to question No. 24.

At about 820 feet.

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — We cannot give any description of these devices, which are not used on the lines of this company.

Lorca to Baza Railway. — There are none.

QUESTION 26. — *Expenses of establishment and upkeep of these devices. Who defrays these expenses ?*

Italian Administrations.

Italian State Railways. — The first cost is about 250 lires, and the annual cost of upkeep is on the average 25 lires per signal.

The cost is borne by the State Railway Administration.

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — Cannot say for reasons given above.

Lorca to Baza Railway. — There are none.

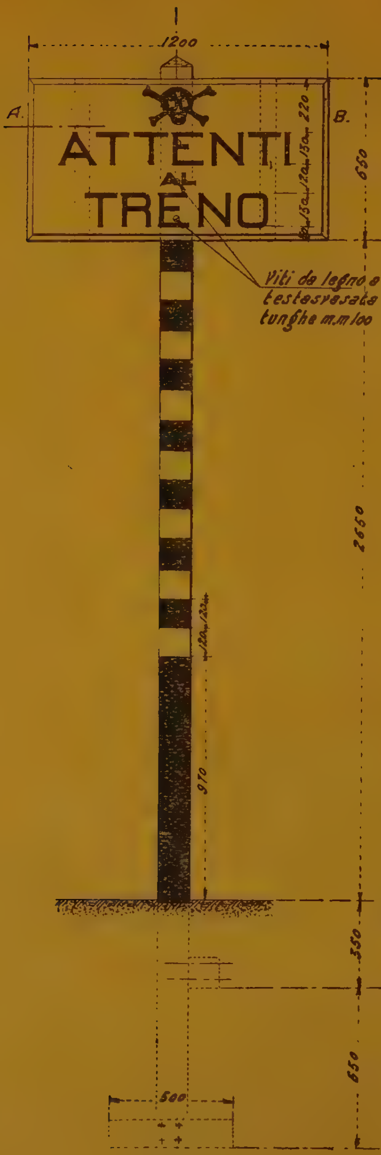


Fig. 6.

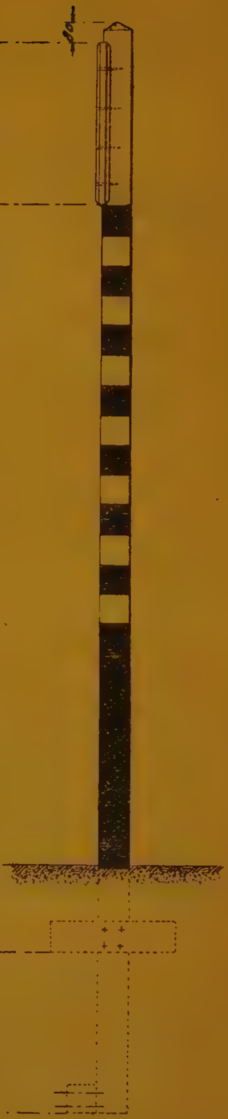


Fig. 7.

Explanation of Italian terms :

Viti da legno a testasvasata, lunghe m/m 100	Countersuck head wood screws 3 15/16 inches long.
Sezione A-B.	Section A-B.
Pianta	Plan.
Viti da legno, lunghe m/m 40.	Wood screws 1 9/16 inches long.

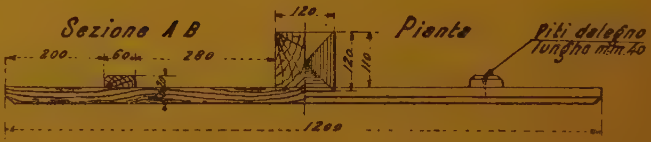


Fig. 8.

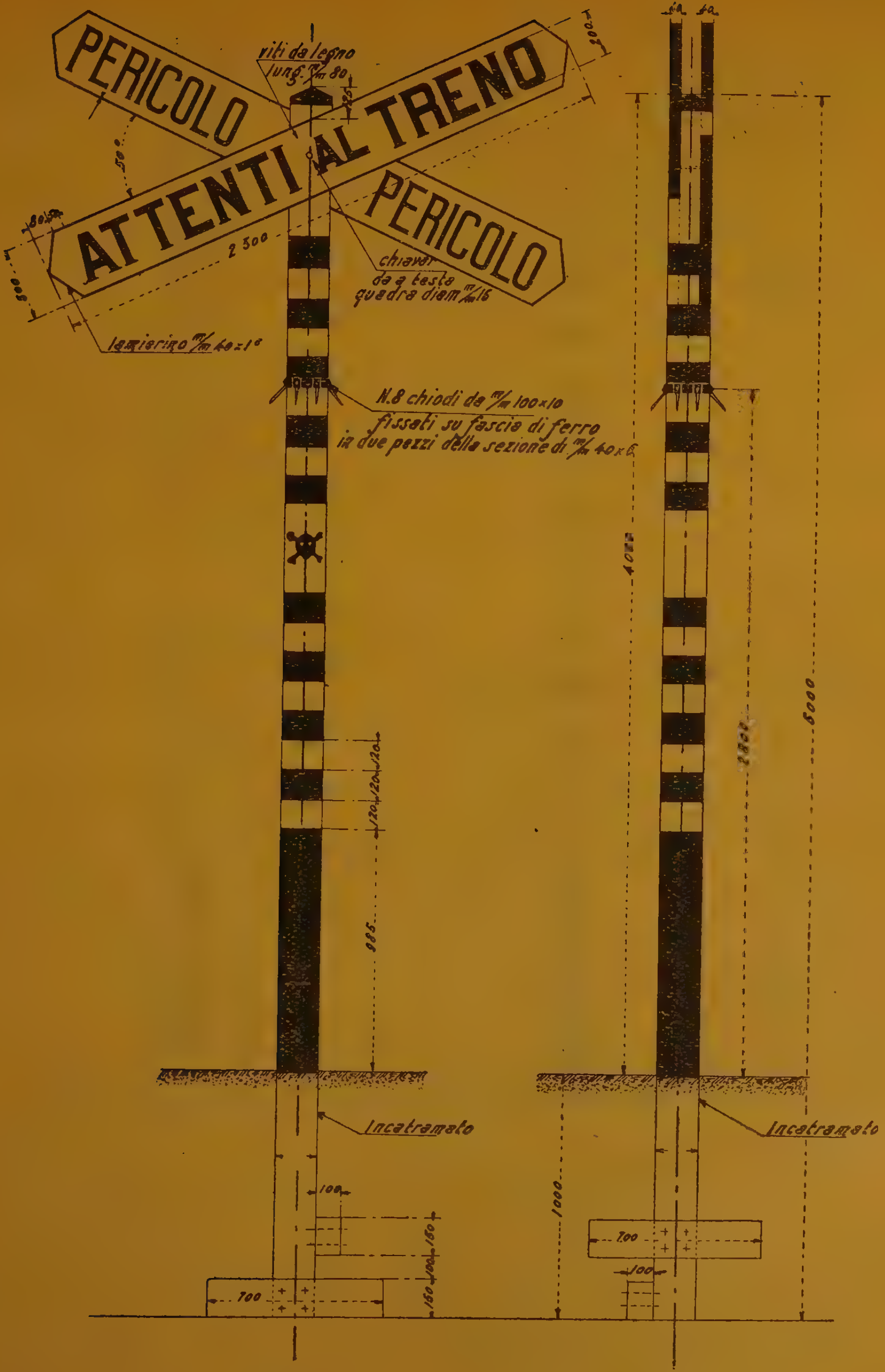

PERICOLO
ATTENTI AL TRENO
PERICOLO
viti da legno lung. m/m 80
200
50°
80
800
2 500
chiavar da a testa quadra diam m/m 16
lamierino m/m 40×1
N.8 chiodi da m/m 100×10 fissati su fascia di ferro in due pezzi della sezione di m/m 40×6
120
120
120
985
Incatramato
100
150
100
150
700
4000
2800
6000
1000
700
100
Incatramato

Fig. 9. Fig. 10.

Explanation of Italian terms : Incatramato = Tarred. — Viti da legno... = Wood screws 3 5/32 inches. — Chiavar da a testa quadra diam. m/m. 16 = Square headed bolt 5/8 inch diameter. — Lamierino = Sheet iron. — Chiodi da... fissati su fascia di ferro in due pezzi della sezione di = Nails... fixed on iron band in two pieces section 1 9/16 inches × 1/4 inch.

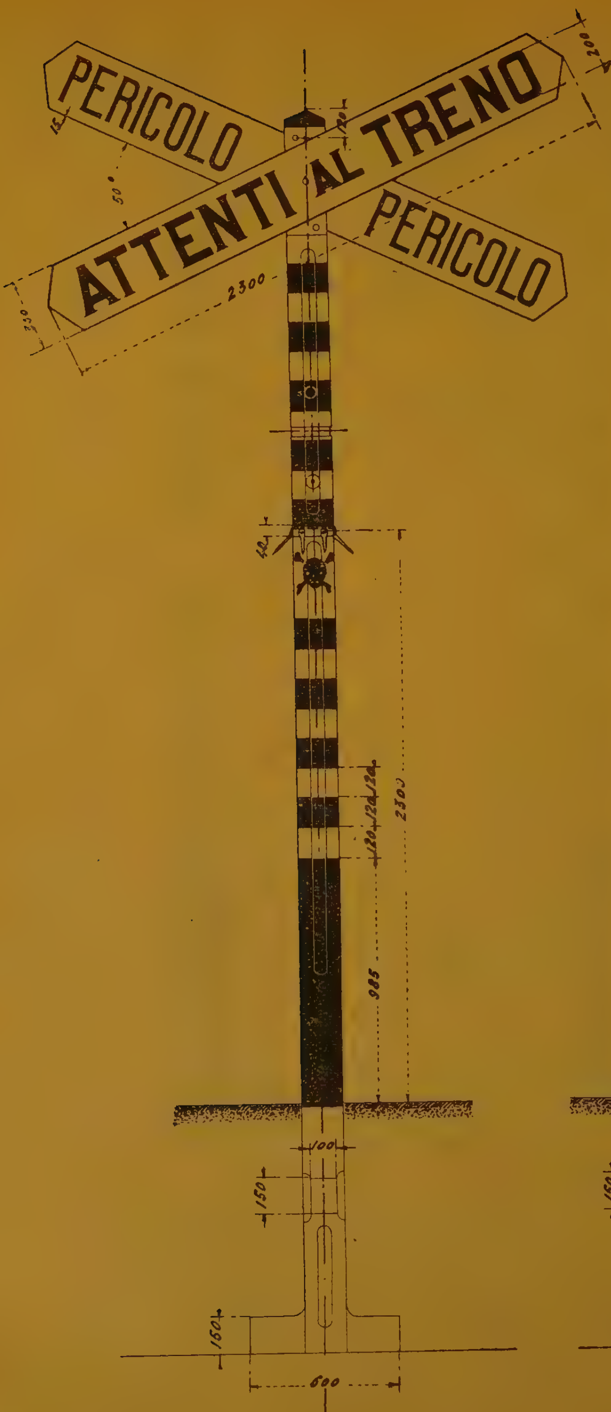

PERICOLO
ATTENTI AL TRENO
PERICOLO
50°

Fig. 11.

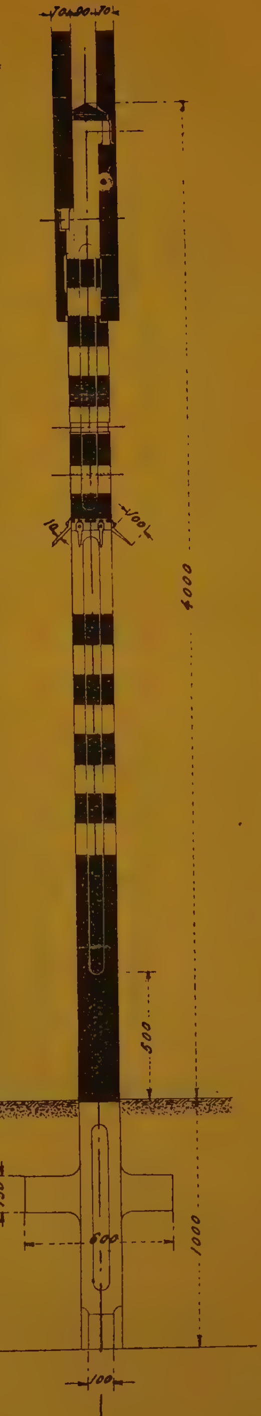


Fig. 12.

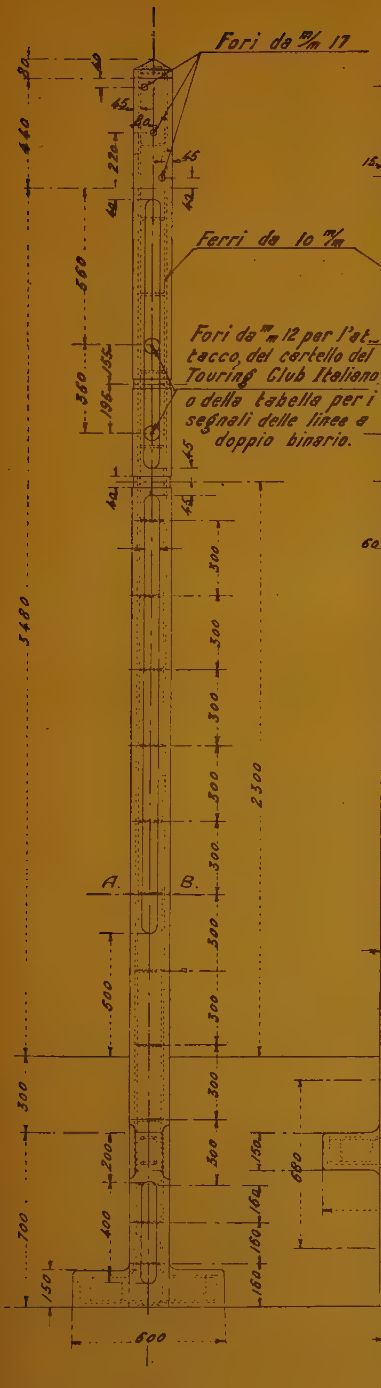


Fig. 13.

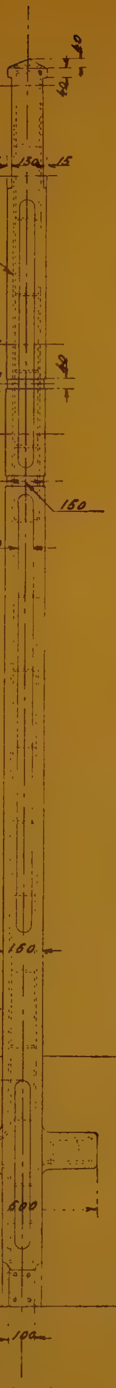


Fig. 14.

Section A-B.

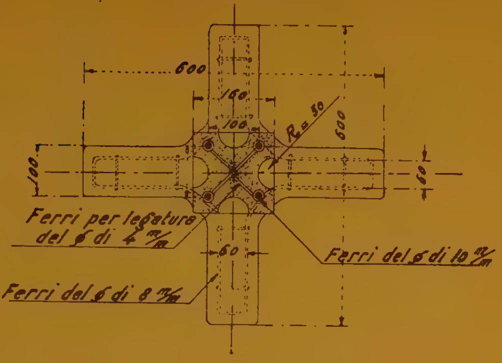
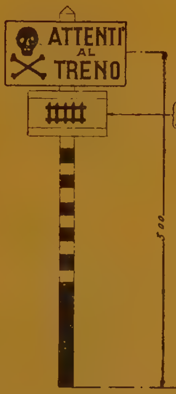


Fig. 15.

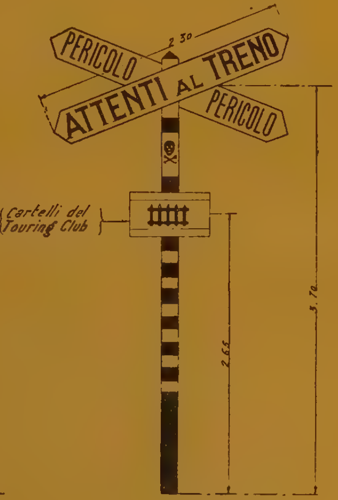
Explanation of Italian terms :

Ferri per legatura del ∅ di... = Reinforcing bars 5/32 inch diameter. — Ferri del ∅ di .. = Bars 5/16 inch diameter.



For less important roads.

Fig. 16



For more important roads.

Fig. 17.

Explanation of Italian terms :

Cartelli del Touring Club = Touring Club sign.

Explanation of Italian terms of figures 13 and 14 :

Fori da = Holes. — Ferri da = Iron. — Fori da m/m 12 per l'attacco, del cartello del Touring Club Italiano o della tabella per i segnali delle linee a doppio binario = 1/2 inch holes for fixing the Italian Touring Club sign or notice indicating double line of railway.

Figs. 13 to 17.

QUESTION 27. — *Does the abolition of barriers necessitate an alteration to the international signal announcing the approach to a level crossing?*

Italian Administrations.

Italian State Railways. — It is thought, generally speaking, that the « Touring Club » international signal, when used to give warning of the approach to an unguarded level crossing, should be modified so as to indicate that the barriers have been done away with.

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — Non-guarded level crossings on this railway are not provided with barriers or any device for closing the crossing.

Lorca to Baza Railway. — There are none.

QUESTION 28. — *Is it obligatory to advise users of the road by means of warning devices that a train is approaching?*

Italian Administrations.

Italian State Railways. — The rules in force do not render obligatory the use of apparatus for giving warning of the approach of trains, since in cases where level crossings are not guarded, these should have a sufficient visibility from both directions.

However, under special traffic conditions or where fog is frequent, the Administration is obliged to provide at certain level crossings apparatus to give warning of the approach of trains.

These devices are at the present time under test.

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — There is no regulation in existence on this railway as regards the provision of apparatus to give warning of the approach of trains.

Lorca to Baza Railway. — No.

QUESTION 29. — *What devices are used for this purpose, either by day or by night?*

Italian Administrations.

Italian State Railways. — There are various types under trial.

a) « WIG WAG » TYPE of the Italian Signal Company.

The three figures give the three aspects of the signal corresponding to level crossing clear, train approaching and railway must not be crossed, and finally, signal out of use.

In the first position (fig. 18) the movable disc does not appear, the bell does not sound, and the lamp which is provided does not shew a light.

In the second position (fig. 19) the movable disc swings backwards and forwards, the bell sounds and the lamp shews a light, and, finally, when the apparatus is not in use (fig. 20), the disc remains fixed in a vertical position, the bell does not sound and the red light is not displayed.

This signal is operated by an electric current provided from a battery of cells and is controlled by a track circuit.

It has given, up to present time, good results.

This system, as is the case with all others working on the same principle, has the disadvantage that it operates and prevents traffic passing over the crossing when a train, during shunting operations, passes on to the insulated section, or when a ballast train or platelayers' trolley is standing in the insulated section.

b) « WIG WAG » TYPE of the « Magnetic Signal Company ».

This type only gives two indications:

If no train is approaching (fig. 21) the movable disc remains stationary and the rod on which it hangs remains vertical, in the same way as if the current had failed or the apparatus was out of order and not working.

On the approach of a train (fig. 22) the disc swings like a pendulum, the lamp shews a light and an electric bell sounds.

This apparatus is operated by a battery of cells, the track forming part of the circuit.

c) « CARLO CONCATO » TYPE. — This consists of a gantry (fig. 23) placed close to the level crossing on either side thereof and extending across the road, being of the same width as the latter. It carries in the middle a strong frame on which, in addition to the signal indications which it displays, may be placed notice boards.

It displays three different indications:

When the level crossing is open, the lamps with which it is provided are extinguished, the bell or the klaxon with which it is provided does not sound.

When a train is approaching, red lights are displayed and the audible signals sound.

If the apparatus is out of action or working improperly, a panel (fig. 24) is displayed which is not shewn in the first two cases.

It is supplied with current from a battery of cells and the track forms the principal circuit.

d) « SIEMENS » TYPE. — By operating mercury switches, the circuits are closed and light a lamp placed on one of the ordinary warning posts, and sound a special bell placed close to the level crossing (fig. 25).

In the case of failure, the apparatus does not work, and no indication is given, which forms an obvious disadvantage of this system.

Spanish Administrations.

Northern Railway of Spain. — None.

Madrid, Saragossa and Alicante Railway. — None.

Lorca to Baza Railway. — There are none.

QUESTION 30. — *Give a concise and complete description of these devices.*

Italian Administrations.

Italian State Railways. — Same reply as for question 29.

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — We cannot give a description of these apparatus, which are not used by this company.

Lorca to Baza Railway. — No.

QUESTION 31. — *What special measures are taken in case of fog?*

Italian Administrations.

Italian State Railways. — As has been said in reply to question No. 28, certain level crossings subject to frequent fogs will be provided with apparatus, now under trial, for giving warning of the approach of trains.

Spanish Administrations.

Northern Railway of Spain. — None.

Madrid, Saragossa and Alicante Railway. — None.

Lorca to Baza Railway. — None.

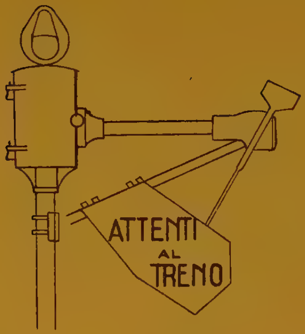


Fig. 18.

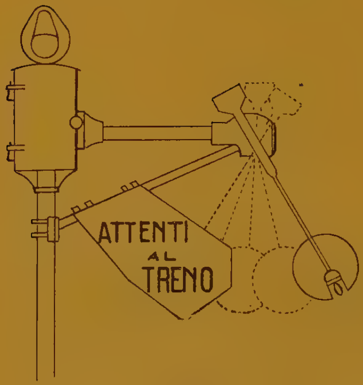


Fig. 19.

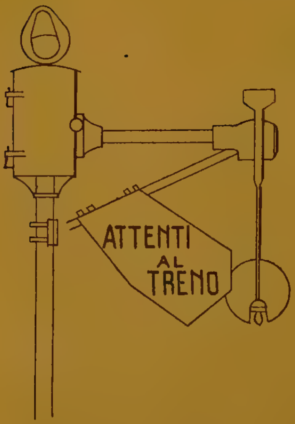


Fig. 20.

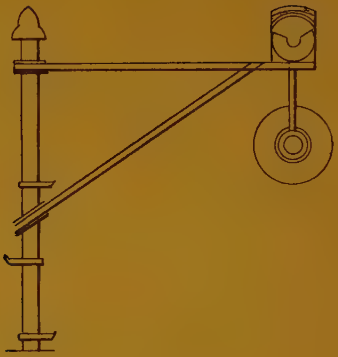


Fig. 21.

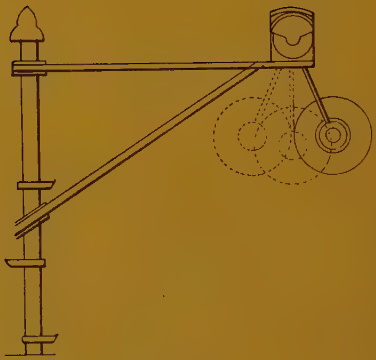


Fig. 22.

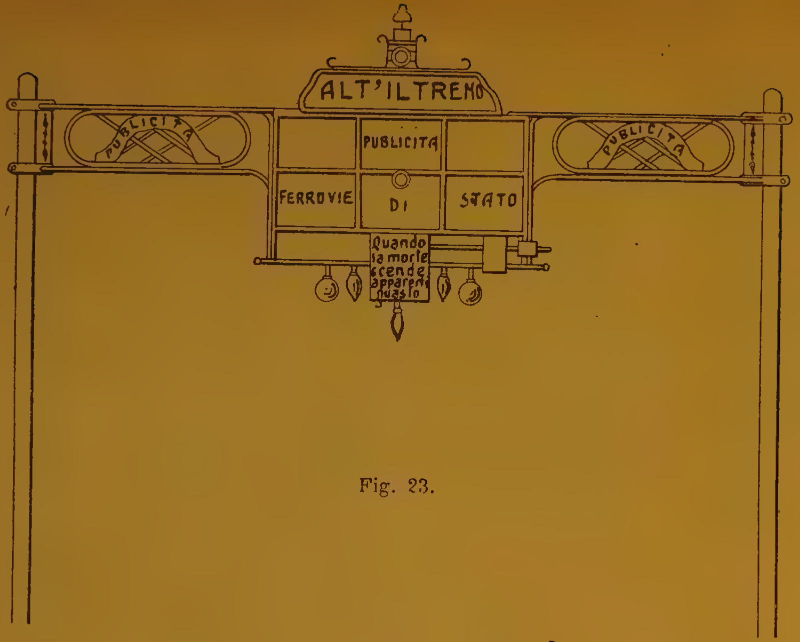


Fig. 23.

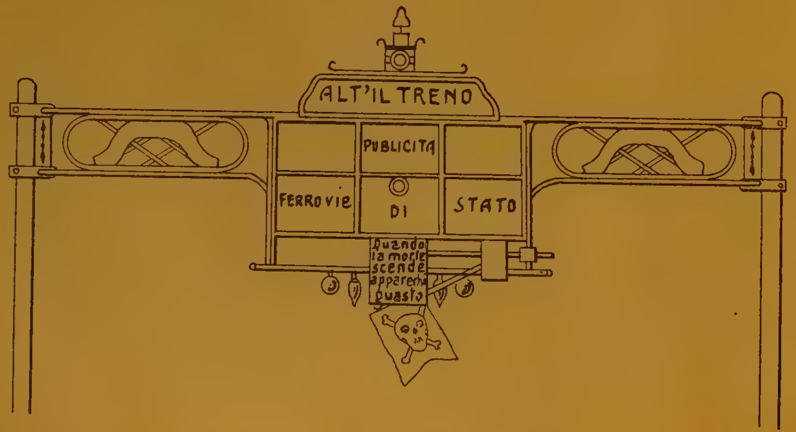


Fig. 24.

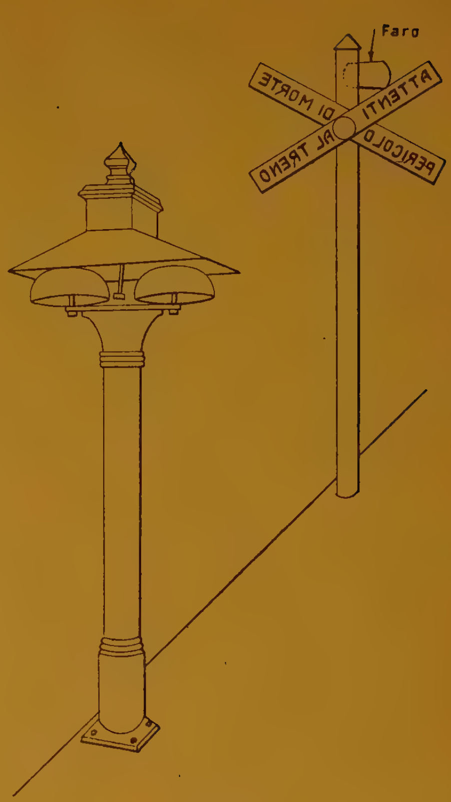


Fig. 25.

Translation of Italian terms :

Alt'il treno = Beware of trains. — Publicita = Notice. — Quando la morte scende, apparechio guasto = When the death's head appears, the apparatus is out of order. — Faro = Lamp

Question 32. — *What is the cost of fixing and maintenance of these devices, and who is responsible for it ?*

Italian Administrations.

Italian State Railways. — The cost is borne by the State Railway Administration.

The first cost of the apparatus described, giving indication for road traffic in both directions, is as follows :

« Italian Signal Company » type, 21 240 lires;

« Magnetic Signal Company » type, 19 300 lires;

« Concato » type, 25 500 lires;

« Siemens » type, 21 400 lires.

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — No cost can be given, as these apparatus are not used.

Lorca to Baza Railway. — None.

Question 33. — *Conditions under which level crossings have to be lighted. Statistical particulars relating to this subject.*

Italian Administrations.

Italian State Railways. — Unguarded level crossings are not lighted; however, there are certain apparatus for giving warning of the approach of a train, as mentioned in reply to question No. 28 and the following, which include the lighting of level crossings as mentioned in the description of these apparatus.

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — None of the level crossings, either guarded or unguarded, are lighted.

Lorca to Baza Railway. — None.

Question 34. — *What is the yearly saving actually due to dispensing with gatekeepers at level crossings ? Proportion of this saving to the number of level crossings where the gatekeepers have been dispensed with, and to the number of kilometres of lines in the system, dividing these lines up into classes if necessary.*

Italian Administrations.

Italian State Railways. — The saving now obtained is about 7 500 gatekeepers, corresponding to about 48 million Italian lires per year.

$$\frac{48\,000\,000 \text{ Italian lires}}{5\,598 \text{ level crossings}} = 8\,574.49$$

(saving per level crossing at which gatekeepers have been abolished).

$$\frac{48\,000\,000 \text{ Italian lires}}{14\,663 \text{ kilometres}} = 3\,273.54$$

(saving per kilometre of track).

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — As we have already said, gatekeepers have not been abolished at any level crossings. They have only been superseded at a few level crossings at which overbridges or underbridges have been constructed.

Lorca to Baza Railway. — None.

CHAPTER IV.

Future situation.

QUESTION 35. — *Why is the abolition of gatekeeping desirable ?*

Italian Administrations.

Italian State Railways. — See chapter III-B.

Reggio-Emilia Railway. — For reasons of economy.

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — It is desirable to abolish gatekeepers at level crossings, for reasons of economy, as the present system leads to a considerable expense which seriously affects the cost of operation.

On the other hand, the responsibility of the company and the attention which has to be given to this question are matters which should be taken into account.

Where means of warning are provided, road users, when approaching a level crossing, should take the precaution of making sure that no train is approaching, and it is probable that the number of accidents would be reduced. With the present method, road users relying entirely on measures taken by the railway company and do not take the trouble to personally guard themselves against the dangers to which they are exposed.

Andalusian Railways. — The various divisions of the railway have the matter of classifying the lines in hand. There are no new regulations on the matter, and the rules which have already been given are followed.

Lorca to Baza Railway. — The reply to these questions will depend on the regulations which are imposed by the Spanish Government if it decides that gatekeepers may be abolished at some or at all level crossings.

The company is seeking powers to abolish some level crossings by its letter of the 16 September 1921, which states all the arguments which justify this step being taken.

Portuguese Administrations.

National Portuguese Railway Company. — Because it would lead to an economy of 800 to 1 000 francs per level crossing per year.

QUESTION 36. — *Legislative regulations to which the extension of this project is subordinated.*

Italian Administrations.

Reggio-Emilia Railway. — Ministerial Decree of the 10 March.

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — There is no administrative rule which authorises the companies to abolish gatekeepers at level crossings. To obtain authority, it would be necessary to replace the gatekeepers by signal indicators placed on the road in the proximity of the level crossing, and warning boards at the side of the railway, so that engines should give warning of their approach to the level crossing by sounding the whistle.

The provision of automatic signals giving warning to road users of the approach of a train does not appear to fully solve the problem, if one considers the possibility of their faulty operation in case of failure, which might cause an accident instead of preventing it.

One might, however, where the importance of the traffic on the roads makes it desirable, increase safety and give warning of the passing of trains by means of apparatus of a perfected type very carefully maintained.

Portuguese Administrations.

National Portuguese Railway Company. — The Government control would oppose this.

QUESTION 37. —*New regulations for the future, and their object.*

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — The new rules should specify the indicating apparatus to be used on the road and on the railway.

QUESTION 38. — *Proposed new methods.*

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — The gatekeepers might be retained at a certain number of level crossings over important roads, and the unguarded level crossings might be divided into two categories in accordance with the amount of traffic; level crossings of the first category would be provided with warning posts.

QUESTION 39. — *Features at level crossings which allow the abolition of gatekeepers to be considered (visibility, number and speed of trains, character and density of road traffic, possible improvements, etc.).*

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — The classification in our opinion should be made in accordance with the quantity of traffic on the public highway which is crossed.

It might be well, however, to take special precautions and to increase the number of warning signals on the road and on the railway in order to compensate for lack of visibility in cases where this is insufficient.

QUESTION 40. — *Classify these level crossings into their various administrative groups according to actual and future regulations.*

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — This railway cannot be dealt with under the present administrative rules as regards the operation of level crossings.

QUESTION 41. — *Approximate number of these level crossings.*

Spanish Administrations.

Northern Railway of Spain. — Gatekeepers might be abolished at 2 000 level crossings.

Madrid, Saragossa and Alicante Railway. — Gatekeepers might be abolished at 1 800 level crossings; this would lead to an annual economy of 600 000 pesetas.

QUESTION 42. — *Distribution of these level crossings amongst the various present methods of gatekeeping given in the table, Chapter III.*

Spanish Administrations.

Northern Railway of Spain. — The level crossings at which we propose that gatekeepers should be abolished consist partly of those in category *A* given in chapter III, paragraph 6; the two other categories would correspond to those under categories *B, C, D, E, F, G* and *H.*

Private level crossings provided with gates which are fitted with a lock and key should be kept as they are.

Madrid, Saragossa and Alicante Railway. — Gatekeepers would be abolished at level crossings of all categories, especially at those under categories *C* and *D.*

QUESTION 43. — *Should it be obligatory to announce to users of the road, by means of warning signals, their approach to a level crossing ?*

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — One might provide on the public road, as we have already stated, warning apparatus in the proximity of level crossings which are not guarded in the case of important roads.

In other cases, it would be sufficient to give warning of the approach to a level crossing where the visibility is insufficient.

Portuguese Administrations.

National Portuguese Railway Company. — It would be advisable to do so.

QUESTION 44. — *What are the warning devices that might be used for this object, either by day or by night ?*

Spanish Administration.

Northern Railway of Spain. — The type of warning apparatus to be used should be investigated by a committee nominated for that purpose.

The warning posts giving notice of the approach to a level crossing might be those now in use, provided that their visibility was increased by means of alternate strips of red and white and by their being lighted. As regards means of giving warning of the approach of trains, the best solution would be perhaps to adopt apparatus operated by a treadle fixed on the rail at a distance from the level crossing which might be 550 yards. These contacts might be arranged in such a way that when a train is passing the warning bell at the level crossing would commence to sound and would continue to sound until the train had reached the other contact situated on the other side of the level crossing.

At the place where the bell is located, an optical signal would be provided fitted with a fixed electric light.

The current passing through this lamp will hold, in a raised position by means of a small electric magnet, a circular sector placed behind the disc, which would shew through an apperture in the latter a red strip when current was passing. In case of failure of the current the sector would fall, displaying in the same apperture the word « avarie » (« out of order ») or some other warning signal.

In this way the absence of a red light during the night or the presence of this inscription during the day would indicate to road users that they should take extra precaution, because in these two cases the bell would not announce the approach of a train by reason of failure of the current or of the electric circuit.

The object of this device would be that in case of failure of the warning apparatus to inform road users that they should take additional precautions in crossing the railway.

As regards the railway, it would be sufficient to place at a suitable distance a notice board marked « Whistle » under a red sign to inform the driver that the cause of his having to use his whistle is the approach of a level crossing and not on account of a speed reduction or a stop.

Madrid, Saragossa and Alicante Rail-

way. — One might adopt the systems which have given the best results on the companies which have made tests.

Portuguese Administrations.

National Portuguese Railway Company. — For lines with a light traffic, such as ours, it would be sufficient to provide one warning post for each level crossing.

QUESTION 45. — *Description and criticism of these devices.*
Should they indicate the number of lines to be crossed?
Should advance signals be fixed?
At what distance from the level crossings?

Spanish Administrations.

Northern Railway of Spain. — If it is necessary to indicate the number of railway tracks to be crossed, one might place on the post carrying the bell a little notice giving this information.

The signal giving warning of the approach of trains would be placed close to the level crossing, and the advance signal would give warning of the approach to the level crossing.

Madrid, Saragossa and Alicante Railway. — It is not possible to describe or discuss the type which it would be advisable to adopt.

QUESTION 46. — *Cost and upkeep of these devices. Who defrays the expense?*

Spanish Administrations.

Northern Railway of Spain. — As the type of apparatus which should be adopted has not been decided upon, it is not possible to give the first cost of equipment or of upkeep.

Signals on the railway and upkeep of the contacts should be maintained at the cost of the railway company, and the other devices should be maintained by the road authorities.

Madrid, Saragossa and Alicante Railway. — For reasons given above, it is not possible to state the first cost.

This cost might be borne by the companies.

QUESTION 47. — *Is it obligatory to signal to users of the road, by means of warning devices, the approach of trains?*

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — As we have said, apparatus giving warning of the approach of trains should only be provided on important and much used roads at crossings which are not guarded. For the majority of other roads it would be sufficient to give warning of the approach to a level crossing by means of a warning post and to place on the railway a notice marked « Whistle ».

QUESTION 48. — *What are the warning devices used for this purpose, by day and by night?*

Spanish Administrations.

Northern Railway of Spain. — We have already given the various forms of apparatus which it might be well to provide at unguarded level crossings.

Madrid, Saragossa and Alicante Railway. — One might adopt the systems which have given the best results on railways which have made trials.

QUESTION 49. — *Concise and complete description of these devices.*

Spanish Administrations.

Northern Railway of Spain. — We have already stated the various apparatus which it might be well to provide at unguarded level crossings.

Madrid, Saragossa and Alicante Railway. — It is not possible to describe or discuss the type which it would be advisable to adopt.

QUESTION 50. — *What measures are taken in case of fog?*

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — In view of the weather conditions in Spain, it does not appear necessary to adopt special measures for cases of fog, because then the vehicles using the public roads would proceed with very great care, and on the more important roads, audible signals would be provided in place of optical signals at a greater distance from the crossing.

QUESTION 51. — *Expenses of establishment and maintenance of these devices. Distribution of such expenses.*

Spanish Administrations.

Northern Railway of Spain. — As the type of apparatus which should be adopted has not been decided upon, it is not possible to give the first cost of equipment or of upkeep.

Signals on the railway and upkeep of the contacts should be maintained at the cost of the railway company, and the other devices should be maintained by the road authorities.

Madrid, Saragossa and Alicante Railway. — For reasons given above, it is not possible to state the first cost.

This cost might be borne by the companies.

QUESTION 52. — *If the abolition of protection is permitted on account of the reciprocal visibility from the railway and the road near the level crossing, what measures have been taken to safeguard this visibility after the protection has been withdrawn?*

Spanish Administrations.

Northern Railway of Spain. — The proposed measures for abolishing gatekeepers are not based on the visibility of the railway and of the road, but upon the condition of the road surface and the amount of traffic thereon.

Madrid, Saragossa and Alicante Railway. — Maintenance of the conditions which justify the abolition of gatekeepers.

Portuguese Administrations.

National Portuguese Railway Company. — Simple notice boards warning the public of danger, as is done in Italy for example.

QUESTION 53. — *Expenses of establishment that would be incurred if abolition of protection at level crossings was made general as far as it is possible to do so.*

Portuguese Administrations.

National Portuguese Railway Company. — Abolition of gatekeeper's house at each level crossing.

QUESTION 54. — *What economies do you anticipate by this method? What would the yearly saving amount to?*

Spanish Administrations.

Northern Railway of Spain. — The annual economy which might be obtained is at present difficult to ascertain, as there is no classification of roads.

Madrid, Saragossa and Alicante Railway. — Would save 600 000 pesetas.

Portuguese Administrations.

National Portuguese Railway Company. — At the present time, a minimum of 1 000 francs per level crossing per year.

QUESTION 55. — *Proportion of the annual amount of such savings to the number of level crossings where protection might be dispensed with, and the number of kilometres of lines on the system, dividing the lines into classes if necessary.*

Spanish Administrations.

Northern Railway of Spain. — The number of level crossings on this railway at which gatekeepers might be abolished would probably exceed 2 000.

QUESTION 56. — *What steps do you consider will be taken in order that further abolition of protection may take place?*

Spanish Administrations.

Northern Railway of Spain and Madrid, Saragossa and Alicante Railway. — Abolition of level crossings might commence in the case of those on roads included in proposed category A, and would continue for other roads. This scheme appears to us more logical than the abolition of permanent-way watchmen.

Deductions arrived at from a careful examination of the Italian replies.

1° The official regulations as regards this important subject are of recent date and are very clear and precise, being drawn up in a most practical manner so as to permit gatekeepers to be abolished at a very large number of level crossings and the corresponding advantages to be obtained, especially the very considerable economy referred to in these replies.

This view of the matter is of recent date, although laterly the traffic on the roads has considerably increased and will increase still further on account of the wider use of mechanical traction.

These two administrations fully realise the considerable expense entailed by the provision of gatekeepers, and rely upon the intelligence of road users to ensure them taking full precautions in order to avoid accidents.

This question has not only been approached from the point of view of the economy realised by the railway, but on the principle that all persons who have had even the most elementary education will avoid as far as possible causing delay or danger to the running of trains, the importance of which should be fully realised and respected.

There was no doubt that during the early days of the transition stage, certain difficulties and perhaps a few regrettable accidents would occur, until the time when the public who use the roads became accustomed to the new system, but in spite of this, these administrations did not hesitate to abolish gatekeepers on all level crossings where technical, geographical and local conditions allowed this to be done, and have extended this policy on a large scale until gatekeepers were abolished at 5 598 level crossings, thus dispensing with 7 500 gatekeepers and effecting an annual economy of 48 million lire;

2° The classification of level crossings depends especially on their importance rather than on the administrative category of the road concerned;

3° On railwayys belonging to the two administrations which have sent us a detailed report, there are in all 13 582 level crossings.

Of this total, 6 952, that is 51 %, are guarded, the remaining 49 % are no longer guarded.

The regulation which allows gatekeepers to be abolished under certain conditions is of great importance in Italy, where, before its publication, the majority of level crossings were guarded.

Actually, of the 6 633 level crossings at which there are no gatekeepers, only 1 016 have been unguarded since the lines were constructed; at the remaining 5 617 level crossings, gatekeepers have been abolished in virtue of the application of this regulation.

It will be seen therefore that had this regulation not been brought into force, the number of level crossings guarded would be 12 569, in place of the 6 952 now in existence, that is to say 92 % instead of the present ratio of 51 %, which corresponds to a reduction of 41 % in the number of level crossings which are guarded;

4° It will be seen from the information given in the answers, that warning apparatus are provided on the ordinary roads but not on the railway. It would be very interesting to know the results obtained by this system, which may be regarded as to tests carried out on a large scale with a considerable number of apparatus in use, which should lead to very useful and instructive data being obtained.

Deductions arrived at from a carefu examination of the two Portuguese replies.

1° The special regulations dealing with this important question are not very numerous and not very clear;

2° The importance of the line has no influence on the method of guarding or classifying the level crossings, which depends only on the importance of the road crossed;

3° The proportion of unguarded level crossings is very high compared with level crossings provided with special gatekeepers.

Actually, from an examination of the information sent in by the two administrations, it will be seen that of 1 775 level crossings existing on the various lines, only 853, that is 48 %, are guarded; the proportion of unguarded level crossings is 52 %;

4° There are no signals giving warning of the approach to a level crossing, either on the railways or on the roads;

5° Gatekeepers have not been abolished at any level crossings since they were constructed;

6° The two administrations are in favour of abolishing gatekeepers, although they anticipate that the Government would oppose so radical a change.

Their principal argument in favour of this measure is the important economy that would result for the railways, and this they estimate at 1 000 francs per level crossing per year;

7° Bearing in mind the very light traffic on their lines, these administrations consider that simple notice boards calling the attention of the public, placed on the road side, as well as warning posts placed by the side of the railway would be sufficient to eliminate all risk of accidents.

Results arrived at from a careful examination of the four Spanish replies received.

1° The official regulations dealing with this important subject are not very numerous and not very clear;

2° Up to the present the classification of the level crossings and the importance of the line has no influence on the method of protecting the crossing, which depends entirely on the importance of the roads crossed.

Recently, arising from the application of the legal eight-hour day for gatekeepers, the Government has considered a scheme of classifying the level crossings, taking into consideration the views expressed by the companies, but up to the present it is impossible to say when this classification will be completed or what form it will take.

This classification, which, as has been mentioned, originated and is based on an eight-hour day for the gatekeepers, might give rise to a demand for the abolition of gatekeepers at a certain number of level crossings;

3° It will be seen from the answers sent in that on the lines of the four companies there are at present 8 559 level crossings, of which 6 245, that is 73 %, are guarded, and 2 314, that is 27 %, are not guarded.

The proportion of level crossings which are guarded is very much greater than on the Portuguese railways, and still greater compared with the Italian railways, since in the latter case the number of gatekeepers was reduced as a consequence of recent official regulations;

4° There are not, generally speaking, any warning signals of the approach to level crossings on the railways, but only on a few lines where their installation is justified by the importance of the line or by special conditions; these generally speaking, are interlocked with the gates.

On the roads the warning posts provided are of the international type and are erected by the « Royal Automobile Club » or by the Public Works Department;

5° Gatekeepers have not been abolished at any level crossings since they were constructed;

6° The companies working the lines are strongly in favour of abolishing gatekeepers at the majority of level crossings, but there is reason to suppose that the Government would oppose such an innovation, which is contrary to established practice. On the other hand, the public might regard it as being solely done with the object of increasing profits and not for simplifying and reducing the cost of operation.

In the near future, a new regime will be established in Spain under a common agreement between the State and the companies, for determining and fixing the rates for each period, in accordance with the cost of operation, in which will be included the costs entailed by the provision of gatekeepers at level crossings; it may be that this time will be opportune to press for the abolition of gatekeepers in order to be able to reduce rates, while at the same time meeting the cost of operation;

7° In the event of gatekeepers being abolished, one might install the necessary apparatus giving warning of the approach to a level crossing on the roads; in this case the apparatus used should be the type found the most satisfactory as the result of experience gained in various countries.

RESUME.

From the notes given above and in spite of the small amount of information received, it is possible to establish certain facts of a general character from which the final summary may be drawn up.

These notes apply to the various questions given in the questionnaire submitted to all the administrations :

1° With the exception of Italy, the regulations affecting the legal and administrative position of level crossings are very few and not very clear.

This confusion has certainly arisen, so far as Portugal and Spain are concerned, on account of the period at which the existing regulations came into force, which, as is also the case with the Italian railways, was a time when the small amount of traffic on the railways did not necessitate any more elaborate methods. The Italian companies having fully appreciated the situation, have modified their rules, but in Spain and in Portugal matters have remained in the same condition as they were at the time when the railways were authorised and constructed.

In none of these three countries has any clear and definite classification of the level crossings been carried out. This matter is treated differently as regards its fundamental principles by all the companies or administrations concerned;

2° It is advisable that the existing guarded level crossings which are to remain in this category in the future should be provided with warning apparatus, seeing that the traffic on the roads which are crossed will every day become more important, especially as regards mechanical traction, and in view of the importance of enabling the drivers of these vehicles to have sufficient warning that they are approaching a level crossing.

The above is of great importance as regards level crossings which are guarded, seeing that for this reason, especially in countries where the matter has been dealt with in a progressive and modern manner, the fact that a level crossing is guarded clearly signifies that it is a dangerous crossing or one to which the approach is difficult.

It is obvious that all these means of giving warning should be erected and maintained by the State, by local road authorities or by other organisations, such as the « Automobile Club » who are specially interested in the road traffic, and it is neither logical nor equitable that the railway administration alone should have to support the cost of installing and maintaining signals which have nothing to do with their operation, and became necessary at a date long after the railway was constructed by reason of the important increase in the amount of mechanically propelled traffic on the roads.

These signs should be of a uniform type so that drivers of vehicles of all nationalities should be able to recognise them, in view of the international character of the traffic now on the roads;

3° Level crossings which are at the present time unguarded may be so, either on account of their small importance, from the fact that they were so classified when the line was built, even in the case of countries where gatekeepers are strictly required, or on account of recent regulations authorising gatekeepers to be abolished in particular cases and under certain conditions.

For the first group of level crossings, it is not really necessary to provide signals or warning apparatus in view of their lack of importance, except where a considerable increase in the traffic on the road crossed renders it necessary to provide more efficient means of protection.

In the latter case and in countries where gatekeepers are considered essential, this becomes automatically necessary from the Government requirements.

For the second group of level crossings, it may be advisable to use the arrangements detailed in the following paragraph;

4° It would be desirable, following the similar measure enforced in Italy, to adopt in Portugal and in Spain regulations authorising gatekeepers to be abolished at all level crossings at which there is no special reason why gatekeepers should be provided, in view of the considerable economy which would result therefrom, not only as regards saving the expense of the wages of the large number of staff employed in this way and of superannuation pensions to be paid in the future, but also as regards the first cost of building gatekeepers' houses, who, in order that they may efficiently carry out their duties, must reside in close proximity to the level crossing for which they are responsible.

If gatekeepers are abolished, it is absolutely necessary that the approach to a level crossing should be notified on either side by warning signals fixed on the road and visible at a distance, or by special apparatus whereby the driver of a vehicle, especially mechanically propelled vehicles, may obey the information given and avoid any collision or accident.

These warning signals, as well as the warning signals preceding level crossings which are guarded, should be of a uniform international type, so that their indications may be understood and obeyed by all.

In view of the obvious advantage which would accrue to the railway administrations from the abolition of gatekeepers at level crossings, the cost of installing and maintaining these warning signals might be equally divided between the railways and the road authorities.

FINAL SUMMARY.

1° It is desirable that, in countries which have not recently done so, laws should be established dealing with the legal aspect of level crossings, subjecting these to regulations which are as uniform as possible and in keeping with the requirements of modern life as regards traffic on the railways and on the roads, in view of the international character of this question, seeing that the considerable increase in mechanically propelled traffic has enlarged the sphere on which the development of the nation depends;

2° Level crossings which are guarded should have a warning placed at a considerable distance along the road in both directions, in order to prevent collisions between the numerous mechanically propelled vehicles running on the road and the level crossing gates, or accidents, should the gates inadvertently be left open.

Warning posts preceding guarded level crossings should be of a uniform type for all nations, in view of the international character of the mechanically propelled traffic. The cost of their erection and maintenance should not in any case be borne by the railway administrations;

3° For unimportant level crossings which have not been guarded since the line was constructed, or as a recent measure, the provision of warning devices is not indispensible;

4° The Congress might adopt a motion with the object of drawing the attention of all countries in which the railway administrations belong to the International Association to the necessity of regulations allowing gatekeepers at level crossings to be abolished when local circumstances permit, especially as regards visibility, irrespective of the importance of the crossing and under conditions to be determined, to which there would be few exceptions, which would allow considerable economy to be effected, and would simplify operation and reduce working expenses.

At these level crossings, it would be advisable to provide warning apparatus on both sides placed at a convenient distance in order to enable drivers of vehicles, especially mechanically propelled vehicles, to act in accordance with their indications, and thus avoid collisions or accidents.

The cost of providing and maintaining this apparatus for level crossings at which gatekeepers have been abolished might be divided between the railway administrations and the road authorities concerned.

[625 .172 & 625 .173]

REPORT No. 3

(all countries, except the British Empire, America and France),

ON THE QUESTION OF MAINTENANCE OF THE TRACK (SUBJECT I-*A* FOR DISCUSSION AT THE TENTH SESSION OF THE INTERNATIONAL RAILWAY CONGRESS ASSOCIATION), (1)

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Figs. 1 to 14, pp. 1679 to 1704.

PREFACE.

The question of the methods of maintaining and repairing the track has already been discussed at previous Sessions of the Congress, but it has been put forward in different ways and criticised from various points of view.

For instance, at the Congress at Milan in 1887, the best methods from the point of view of economy and safety in doing the work were examined, and at the Paris Congress in 1900 the restrictions and delays due to maintenance work in relation to the speed of trains were considered.

Methods relating to maintenance work were also referred to in question II in the programme of the last Congress (Rome, 1922).

From the reports issued by the Congress at Rome on the question of the maintenance of railway tracks, it appears that in the course of the last ten years the loading on the axles and occasionally also the speed of trains have increased. On the whole, a general increase of stressing the superstructure was observed due to increase in traffic, which naturally exercises a great influence on maintenance procedure, especially in those parts where the construction of the track has not a sufficient margin of strength to meet these new conditions. The influence of this increase in traffic is shown by the greater and more rapid wear that takes place, and consequently railway administrations have had to resort to the application of technical measures with a view to reducing to the utmost possible limit the premature wear of the superstructure.

This object is attained partly by adopting more suitable constructive methods, such as strengthening or renewing the superstructure, and partly by perfecting and improving in a technical sense the upkeep of or repairs to the track.

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(1) This question runs as follows : « Different methods of maintenance and repair of the track. (By the administration, by contractors, by piece work or premium system. Mechanical appliances, etc.). Comparison from the technical and economical points of view. »

(2) Translated from the French.

The economic side of the question of repairs also has a bearing which is no less important. An engineer engaged in this work should look at it from the economical side, as well as from the technical point of view. The excessive cost of maintenance resulting from the abnormal state of the labour market during the last ten years having upset all economic conditions, forces railway administrations to give special attention to economy in the methods by which the work is done, and to try at the same time to reduce as much as possible all work that is not absolutely necessary. The technical and economic sides of all undertakings are closely related, and for this reason it is necessary to estimate properly and examine minutely each method by which the work has to be done from these two points fo view, and from their respective angles.

The chief object in the maintenance of the superstructure is to obtain a good solid track which will be as durable as possible, and of so safe a nature that the rolling stock suffers a minimum of damage, and that the life of the component parts of the superstructure should be as long as possible. This object should be obtained by the simplest technical methods and at the lowest cost.

If from a broad point of view we take into consideration what is necessary for safety, we must look at the methods by which the work has to be done from two standpoints, technical and economic, the characteristics of which, however, are opposed to one another. The technical idea is to have a superstructure that is irreproachable on all parts of the track, in order to guarantee the complete safety of running; whereas the economic side of the question requires that no work should be done that is not absolutely requisite in order to maintain the track in condition.

It is necessary, therefore, to establish a certain balance so as to satisfy as far as possible these two conflicting interests.

The methods by which work is accomplished today are characterised by progressive improvements, both technical and economic.

It is to be regretted, however, that the time has not yet arrived when we can profit from the results of observations already made, and come to some definite conclusions. We must also not lose sight of the fact that the times in which we are now living have not yet shaken off the abnormal conditions due to the years of war, and it will take some time before the economic conditions which were so completely upset by events in so recent a past will be completely restored.

The influence of the war and its aftermath on maintenance work relating to the track has been more or less in evidence everywhere, and those States which suffered more directly are faced with the necessity of having to make good that which was neglected during the war.

Since this time numerous social measures have been introduced, the effect of which has also had an influence on the class of work, especially the introduction of the eight-hour day, coupled with a whole list of other social reforms. For instance, in various countries railway administrations have been legally obliged to pay their temporary staff after having served some time, according to the rate paid to those employed permanently.

Among the various measures brought forward, some aim at the restriction of unemployment and affect the railway companies from a general point of view rather than an individual one. The period after the war is also notable for the marked growth of the influence of trade unions, which increases as these associations grow in power and size.

It is natural that these conditions have exercised and still exercise a great influence on the results of work obtained, but these results are not yet of a sufficiently stable character to serve as a guide for future procedure, or even that of normal times.

Account should also be taken of what is now happening in current practice, which is not without influence on the general procedure of the maintenance department.

Many railway administrations are at present trying to find a remedy for unfavourable economic results by the help of a more efficient administrative organisation based on business principles. These administrative organisations also have a direct as well as an indirect influence on the maintenance of the track department of railways. Having been too much taken up with these details, they have not yet been able, as in ordinary times, to give the necessary attention to the question of the right methods for maintenance work, and consequently no particulars, or very few, have yet been given.

The question forming the basis of the object of this report is, however, of such importance that it deserves to be followed very closely and thoroughly discussed.

We should also not forget to point out that the time allowed for preparing for discussion on this subject will be reduced to a minimum on account of the short interval between the ninth and tenth Sessions of Congress.

In consequence of the short time at our disposal to arrange this report, it has also been necessary to curtail the time allowed to the administrations for sending in their replies to the questionnaires, the result being that of the twenty-four to whom questions were addressed, replies have only been received from nine companies.

If we consider that the cost of labour represents the chief item of expense for the whole of the costs debited to maintenance of the track, it will be seen how important it is to give the closest attention to the methods by which this work is done.

A thorough examination of the latter, and especially keen observation of the results will add greatly to their improvement, and consequently to the increase in safety of traffic, allowing at the same time economic advantages to be obtained. The results of the discussion of the question with which we are occupied cannot, for reasons mentioned above, actually be of use, except to prepare for and follow up the study of the subject. May we be permitted, therefore, to express the hope that the question of dealing with track maintenance, or at least the rational principles concerning it, will again be placed on the agenda for the next session of the Railway Congress.

CHAPTER I.

Methods in use for track maintenance.

Methods relating to maintenance of the superstructure may be examined from the point of view of the general organisation of the work, and also as regards the details concerning the operations.

Methods in general use for track maintenance.

Generally speaking, the methods in use by the different railway administrations, though very varied in their nature, may be reduced in principle to two kinds only, namely :

1° Maintenance by « organised inspection »;

2° By the method of « general relaying ».

All other methods are only combinations of these two principal methods.

The chief advantages of these methods have already been examined at previous Congresses, so that it would be superfluous to repeat details in this report.

As shown in the following table, some administrations give preference to the method of general inspection and repairs, while others adhere to the system of general relaying, or combine the two.

In order to make a complete statement on the subject, we may say that the Imperial German Railways introduced in 1914 on some of their branches a method called « Planmässige Gleispflege », which consists of a general relaying of the superstructure at certain periodical intervals, between which repairs are carried out as a result of ordinary inspection and reports.

General relaying takes place every three years on main lines; every four years on lines where the traffic is light; and every five years on branch lines.

The time fixed for commencing the general relaying depends on how long the sleepers or the ballast will last before renewal becomes necessary.

The Imperial Ministry of Transport at Berlin came to the conclusion in 1923 that the system of general relaying alone allowed the cost of maintenance of the component parts of the track to be reduced to a minimum. Maintenance by flying squads of local sections that had become defective (sinking of the track, etc.), had a bad influence on the general stability of the track, and should be replaced by a general relaying of the superstructure.

Every railway company has naturally its own reasons for deciding according to its own special circumstances the best method to adopt.

An objection may be raised against the method of maintenance by ordinary inspection, inasmuch as by repairing defects in the superstructure only as they become visible, other defects may remain hidden from sight for quite a long time, until at last they may show themselves on the surface. That is to say that finally the results of some negligence may become apparent, such as premature distortion and abnormal wear of different parts of the superstructure, etc.

To a certain extent this method fails to give an assurance that all defects have been dealt with as they should have been.

The Swiss Federal Railways, who make use of this method exclusively, obtain satisfactory results, but only when

Table No 1.

Number.	RAILWAY.	*Methods adopted for maintenance of the track :*		
		A. *Over the whole line.*	B. *On main and secondary lines.*	C. *On branch or local lines.*
1	*Belgian State Railways* . . .	General relaying.	...	...
2	*Danish State Railways* . . .	By inspection. This method includes the spring-time relaying, and that of the autumn, which is less comprehensive. The renewal of material is as a rule only carried out during the summer season. Before commencing any important work the engineer in charge inspects the state of the track, and his report serves as a guide to decide what repairs shall be done and the number of workmen required. Less important work is attended to by the sectional foreman or ganger.		
3	*Northern Railway of Spain* . .	Periodical relaying, which consists of repairing a greater or smaller length of track according to the requirements of construction or working conditions.		
4	*Italian State Railways* . . .	General relaying.	...	...
5	*Norwegian State Railways* . .	By inspection.	...	...
6	*Dutch State Railways* . . .	...	General relaying.	By inspection.
7	*Portuguese Railway Company.*	General relaying from May to October, and by inspection the remainder of the year.		...
8	*Swedish State Railways* . . .	By inspection.	...	...
9	*Swiss Federal Railways* . . .	By inspection.	...	...
10	*Czecho-Slovakian State Railways.*	By inspection. General relaying is on trial on the main lines.		...

Number.	RAILWAY.	General relaying.		
		Period during which the method of general relaying has been in operation.	*Does general relaying also include :*	
			Cleansing the track ?	*Continuous renewal ?*
1	*Belgian State Railways* . . .	1 year.	Yes.	Yes.
2	*Danish State Railways* . . .	...	...	...
3	*Northern Railway of Spain* . .	...	No.	No.
4	*Italian State Railways* . . .	30 years.	No.	No.
5	*Norwegian State Railways* . .	...	..	...
6	*Dutch State Railways* . . .	10 years.	No.	No.
7	*Portuguese Railway Company.*	23 years.	No.	No.
8	*Swedish State Railways* . . .	...	...	..
9	*Swiss Federal Railways* . . .	...	...	..
10	*Czecho-Slovakian State Railways.*	1 year.	No.	No.

Number.	RAILWAY.	**General relaying.** *Successive order in which the various operations are accomplished.*
1	*Belgian State Railways* . . .	According to the organisation given in the instructions of the French Eastern Company.
2	*Danish State Railways* . . .	...
3	*Northern Railway of Spain* . .	1) Dismantling the track. 2) Inspection of its condition and replacement of material the condition of which renders it necessary; rectification of the gauge. 3) Repair of the bed. 4) Levelling, ramming, raising and adjusting the superelevation. (5) Adjustment of the track and foundation.
4	*Italian State Railways* . . .	1) Dismantling the track. (2) Inspection, replacing material, rectification of the gauge, position of sleepers, and rails that have been displaced. 3) Ramming, adjustment of the levels and trimming of the track. (4) Trimming the track and re-establishing the normal section of the ballast. 5) Re-establishing the section of the banking. Any supplementary work that may be necessary.
5	*Norwegian State Railways* . .	...
6	*Dutch State Railways* . . .	1) Inspection of the track. 2) Taking to pieces. 3) Inspection of material, replacing material, repairs to material that may be used again. (4) Examination of the track and rectification of any defects. 5) Raising, ramming and trimming the track. (6) Re-establishing the section of the ballast.
7	*Portuguese Railway Company.*	Weeding. Rectification of the gauge and superelevation of the rails. Replacing the sleepers and minor material. Ramming the sleepers. Re-establishment of the section of the ballast.
8	*Swedish State Railways* . . .	...
9	*Swiss Federal Railways* . . .	...
10	*Czecho-Slovakian State Railways.*	See the order of succession in the text further on.

Number.	RAILWAY.	General relaying.	
		Period allowed.	*Influence on the speed of trains.*
1	*Belgian State Railways* . . .	One year is allowed on main lines on which more than 40 trains per day are running, and on branch lines where there are more than 80. On other lines with lighter traffic two to six years is allowed.	Except in the case of renewal of material, when the speed of trains is reduced, general relaying has no effect on the traffic.
2	*Danish State Railways* . . .	. . .	. . .
3	*Northern Railway of Spain* . .	According to the particular conditions. (For instance, two years is allowed on the Madrid-Irún line).	General relaying has no influence on the speed of trains.
4	*Italian State Railways* . . .	In general, those lines which carry over 15 000 t. per day are allowed one year. Two years for 3 000 to 15 000 t., and three years for lines carrying only 3 000 t. or less.	The speed of trains is in no way affected.
5	*Norwegian State Railways* . .	. . .	. .
6	*Dutch State Railways* . . .	Two years.	Ditto.
7	*Portuguese Railway Company.*	Two years.	Ditto.
8	*Swedish State Railways* . . .	. .	. .
9	*Swiss Federal Railways* . . .	. . .	. . .
10	*Czecho-Slovakian State Railways.*	See text.	Ditto.

Number	RAILWAY.	General relaying.		
		Is it advisable to proceed with general relaying on both tracks at once on double lined railways?	*In addition to general relaying the following upkeep operations are taken in hand:*	*Practical results obtained by this method:*
1	*Belgian State Railways*	General relaying is accomplished on each track separately in the opposite direction to the running of trains.	Unimportant partial repairs, where necessary, weeding the track, cleansing ditches, trimming banks and hedges. Odd repairs.	The administration is of opinion that general relaying with repairing in the interval between general relaying is the best method, from both economic and technical points of view.
2	*Danish State Railways*	...	..	...
3	*Northern Railway of Spain*	No.	Ditto.	The adoption of this method considerably reduces small upkeep repairs, and produces an economy in the cost of labour.
4	*Italian State Railways*	No. Besides the difficulties which originate in work done simultaneously on both tracks of a double line, it is found preferable to proceed with the relaying in the direction in which trains are running	Partial repairs when reported necessary. Special inspection of joints. Weeding. Odd repairs.	Very good results have been obtained. The lines are kept in good condition as far as can be seen, and all defects are repaired, including those which are not always very evident. The method of « general relaying » at periods according to the importance of the line and amount of traffic gives every satisfaction from the point of view of keeping the track in good condition, and for assuring the safety of traffic.
5	*Norwegian State Railways*	...	...	...
6	*Dutch State Railways*	No.	Partial repairs when necessary.	Experience so far has been encouraging.
7	*Portuguese Railway Company.*	No.	Partial repairs.	Ditto.
8	*Swedish State Railways*	...	...	...
9	*Swiss Federal Railways*	...	...	..
10	*Czecho-Slovakian State Railways.*	No.	Ditto.	Same as No. 1.

Number.	RAILWAY.	*Method « By inspection ». Results of experience.*	*Maintenance of lines of small importance (entrusted to line men. gate keepers, etc.)*	*Utilisation of the method of shovel-packing for sleepers.*
1	*Belgian State Railways* . . .	The administration has abandoned the use of the method « by inspection » considering it uneconomical on account of the time lost, and because supervision of the workmen was difficult.	The gate keepers have to attend to 50 metres (165 feet) of track on each side of their level crossings, to keep the bolts and nuts of fishplates tight, to keep the track tidy, remove snow, sweep the roadway several times a day, and clean ditches and gulleys.	Shovel-packing is being tried.
2	*Danish State Railways* . . .	In Denmark, which does not produce its own steel, the administration has every incentive to make use of the most economical method for giving the greatest possible life to the material, and considers that this is the best for the purpose.	The gate keepers are only expected to keep their crossings clean.	This method is not in use.
3	*Northern Railway of Spain* . .	...	Gate keepers are not allowed to do any repairs to the track.	This method is not in operation.
4	*Italian State Railways* . . .	...	Upkeep work of the smallest importance is entrusted to the line men. Gate keepers are particularly concerned with the work of cleaning the spaces between rail and check rail, and water their crossings in summer.	Shovel-packing has only been tried, and no definite results are yet to hand.

Number.	RAILWAY.	*Method « By inspection ». Results of experience.*	*Maintenance of lines of small importance (entrusted to line men, gate keepers, etc.)*	*Utilisation of the method of shovel-packing for sleepers.*
5	*Norwegian State Railways* . .	The administration considers the method « by inspection » the best and probably the cheapest.	. . .	This method is not in use.
6	*Dutch State Railways* . . .	The administration is of opinion that the method « by inspection » is sufficient for local lines.	No maintenance work.	This method is not in use.
7	*Portuguese Railway Company.*	. . .	Work of small importance is done by the line men.	This method has just been introduced.
8	*Swedish State Railways* . . .	. . .	. . .	. . .
9	*Swiss Federal Railways* . . .	The method « by inspection » gives satisfactory results providing that the defective parts of the superstructure are renewed in time, the bolts, etc., are kept tight, and general repairing done periodically.	Keeping the track and its approaches clean, tightening bolts, weeding in the neighbourhood of the signal boxes.	This method is on trial, but no conclusion has yet been arrived at.
10	*Czecho-Slovakian State Railways.*	. . .	Ditto.	This method is not in use.

repairs are done periodically, which in sum is the fundamental principle of the method of « general relaying ».

On lines where the superstructure is not periodically attended to over the whole length, numerous defects appear regularly in the spring in a remarkably short space of time, due to thaw, so that the ordinary gangs are not able to do the necessary repairs quickly enough. In the short time they have at their disposal, they as a rule attend to the most serious defects first, though somewhat superficially, which necessitates the frequent moving about of the gangs, by which much time is lost. On the other hand, though the defects which have been noticed have received attention, the cause of these defects occasionally exists.

From the economic point of view, however, the worst feature in the method of upkeep of the track « by inspection » is that it is very difficult to efficiently control the work, and from the technical point of view this method of procedure does not give sufficient guarantee of the lasting nature of the work as does the system of continued and systematic relaying.

This second method of working is known in its various aspects as « general relaying », « periodical relaying », and, in Germany, under the name of « Planmässige Gleispflege », etc. The general principle of the continued revision of the superstructure consists in carefully examining periodically the whole of the superstructure that is due for this, removing all defects, and replacing all material that has become worn, out of shape or damaged, so that the track shall be put into such a condition that no further repairs or renewals of any importance will be required between two successive revisions, and so that the wear of the component parts of the track shall not exceed the normal amount before the next revision is due. General relaying is accomplished systematically with all possible care, taking into account the gauge limits allowed, so as to eliminate defects right up to their causes.

Instead of employing several small and isolated groups of men, only one gang of larger size works in each district or section under properly organised management, so that not only the control of the operations, but the control of the gangs, is possible. Each year systematic repairs of a fixed portion of the track are effected, so that after a period of from one to several years the whole of the district or section has been revised. For this purpose only such work that is absolutely necessary is done in order to obtain a superstructure in the requisite condition. In the intervals between general relaying it is not as a rule necessary — with the evident exception of some odd cases — to replace any sleepers or rails, or cleanse or repair the ballast to any great extent. It is even rare that much of the smaller material has to be renewed, so that maintenance of the permanent way resolves itself into slight repairs and upkeep, which can be attended to by a reduced staff.

The advantages of continued revision are both economical and technical.

In the first place it gives the possibility of perfect supervision and control.

The work is done with regularity and to a programme made out beforehand, and not according to an arrangement distributed over a number of years in view of the financial situation, but also to a detailed programme arranged for the most convenient season or for a time when the work must be done. The result is that this work is more perfectly done, because concentration makes the technical supervision of it more efficacious, and the organisation of labour cheaper. The amount of work done can be gauged by comparing it with known normal operations from which the good or bad results of the method may be estimated. Thanks to a systematic inspection of the superstructure, its actual condition is found and even hidden defects are disclosed, the causes of which can be eliminated. It is in this way that the supervisers become thoroughly acquainted with the peculiarities as well as the condition of their lines, and if the defects are attended to in good time, the life of each of the component parts of the superstructure is lengthened, and a more economical use of the meterial is the result. As this has reference to important work, an economical use can be made of mechanical devices, a method which has also the advantage of enabling a good condition of the superstructure to be obtained in all its parts for some time to come, and the certainty that the track is safe for traffic.

It was found that on some of the lines in Czecho-Slovakia, where this method is being tried, its advantages lay in the fact that insufficiently experienced supervisers were inclined to adopt measures which were too costly for the maintenance of the superstructure, and prematurely changed the material, particularly the sleepers. On the other hand, the disadvantage of premature renewal is compensated for by the increased life of the component parts of the track on account of the systematic upkeep of the material.

From the economical point of view, it is particularly important to judiciously estimate the degree of perfection in which it is necessary to maintain the superstructure, on account of the loading on the axles and the traffic on the line, and to decide exactly the length of the interval between the relayings. In making use of the method of continued relaying, repair work must be limited, as we have already pointed out, to small upkeep jobs. As soon as it is apparent that numerous partial rectifications of the level and outline of the track should be urgently attended to, this indicates clearly that the superstructure is already in need of relaying.

It is these indications which in practice determine the length of the intervals between successive relayings. In normal circumstances when relaying is in progress, only work is done proportional to the length of the next interval of time which is fixed by traffic conditions and the requisite quality of the superstructure.

When, however, a trial is made on a line not yet accustomed to this method, it is at first necessary to do work that is more important then would be required on a line that has had the system in use for some time, because in the transition from the old method « by inspection » to that of « general relaying », it is frequently necessary to eliminate defects which have existed for a long time, some of which date from the first laying of the track, or may have been left at the last time of repairing, when the work was perhaps not done with all necessary care.

As a general rule, the length of the interval between two successive relayings depends on the construction of the track, its state, its curves and gradients, its age and system of working, as well as the quality of the material used, the quality of the ballast and the nature of the foundation; also the amount of traffic, the speed of trains, and whether the track is loaded in both directions with an equal amount of tonnage, to the speed and number of trains, and finally to the local climatic conditions. If the interval between two relayings is too short, a frequent repetition of repairing increases the cost of maintenance. On the other hand, if this period is allowed to become too long, premature renewal of the material will be necessary. The economic result of the work should therefore be based on the exact determination of what the length of the interval should be between the general relayings. On main lines where there is much traffic, the length of this interval should not be excessive.

It is possible, however, to considerably lengthen it by interpolating a smaller revision between two thorough ones. For instance, the yearly revision of the track in which the superstructure is continually receiving attention in a more rapid but less complete manner. The combination of these revisions and fixing the right intervals depends of course on the experience acquired from direct observation, and the exact determination of this interval should agree with the technical requirements of the track and as far as possible with the financial aspect.

From the point of view of the technical and economic results of the work accomplished by the method of continued revision, particular importance should be attached to the manner in which the successive order by which the work is regulated, that is to say, the succession of operations which should be arranged so as to avoid repetition work, that one operation does not delay another, and that during repairs to the superstructure all may be accomplished according to the arranged programme.

All depends, therefore, on the order in which the various operations are taken in hand and not departed from except for important reasons. Some of the railway administrations give entire liberty to the head ganger in deciding how the work should be distributed.

The German Railways, for instance, give complete latitude to the official in charge of the district, under whose authority all maintenance work is arranged. The Swiss Federal Railways leave all responsibility of the work to the initiative of the district foreman. This latitude is particularly characteristic of the method of upkeep by inspection. On the other hand, the characteristic of continual revision necessitates a system even in the order in which the various operations should be done. The determination of the most appropriate order in which continual revision should be accomplished depends on local labour conditions, and for this reason it is not possible to state a fixed method of working except on general lines. The result is that from what has been said as regards general relayings, these railway administrations make use, for the general regulation of the order in which the operations follow one another, of the method first adopted by the French Eastern Railway.

The regulation of the work during general relaying is greatly influenced by whether the system known as « shovel-packing the sleepers » is in use or not.

This method, which takes the place under certain conditions of ramming the sleepers, and provides compensation for small differences in the level, is not yet, from what we can gather from the answers received, in extensive use, and is only on trial in a restricted sense by a few railways, with the exception of Belgium, where it was introduced over the whole system in 1923. We can form no conclusive opinion from the replies sent in that this method, which is the most appropriate for continued revision, will be enforced generally. It will be necessary to wait some time longer in order to know to what extent this shovel packing of the sleepers will be in general use, and the influence it will have on the regulation of continued revisions as is already the case on French railways.

The Czecho-Slovakian Railways, where continued revision as well as shovel packing of sleepers are now on their first trial, have only made use of this method so far as their main lines are concerned. Generally speaking, the work is arranged as follows :

a) Preparatory work.

The foreman of sections responsible for the upkeep of the track make out a graphic programme of the relaying several years in advance, and submit it for approval to the competent authority of the State Railways. This authority, after having inspected the track, gives a decision as regards the work that may be done.

The preparatory work relating to each of the revisions for each year separately are taken in hand during the second half which precedes the continued revision.

This work consists of :

1° Staking out the levels of the track, the graphical representation of the section in length, as well as getting out a plan showing the requirements necessary for levelling and other work to the best advantage;

2° Staking out and centering the rail thus adjusted;

3° Report on the condition of the superstructure, from the result of which a list is prepared of the material and tools required, deciding on the spot where they shall be sent, and arranging a detailed programme of the work to be done;

4° Distribution of material and tools from the depot, and other preparations for relaying, such as drilling sleepers, that have been sent along, fitting them with sole plates, etc.

During this preparatory work the following measures are taken :

1 and 2. — In any changes in levelling it is necessary that the sinking resulting from traffic conditions should not be aggravated. At the same time any rectification of the level should, as a general rule, only be done after the track is lifted. On the other hand, lowering should only be resorted to in very exceptional cases. Marking out of the centres of the main lines is done by means of stakes placed at equal distances from the new centre of the rail, and on the outer side of curves.

3. — The provisional inspection of the state of the track, as well as the provisional work of staking out, is to furnish the necessary detailed basis for arranging the programme and the cost of the general relaying.

The approximate number of sleepers required is fixed after an inspection has been made, in the course of which the number of sleepers that may be used again is fixed after they have received suitable repairs, such as levelling the surfaces, drilling new holes, binding split sleepers with iron bands, etc., so that they may be put into service again until the next relaying takes place.

Renewal of rails is carried out when it is found on inspection that they have defects which might endanger the traffic, such as defective material, cracks or fractures, or a serious amount of wear and distortion which it is not possible to repair, etc.

In inspecting minor material, particular attention is paid to the joints, in order to make certain that they contain no cracks, and that their bearing surfaces are not abnormally worn. The state of the bolts and coach screws is also examined so as to ensure that the fish-plates, sole plates, etc., are not loose or broken.

One special point in the examination of the condition of the track is that of finding out any displacement which has taken place through the action of creeping.

Every rational method is tried to prevent this displacement of the rails, and the track is held in place by suitable arrangements after the rails have been put back in their normal position.

The inspection of the condition of the superstructure includes gauging the lines and the superelevation, as well as the angle at which the rails should be set.

The ballast must also be examined to see that its permeability is in good order, and if not, to make such arrangements as to put it in good condition again without disturbing the bedding if this latter happens to be in good condition. Impermeable ballast made up mostly of sand or fine material is nearly always replaced with new ballast.

When it is necessary to disturb the bedding under the sleeper and to ram the latter after the ballast has been cleansed, it is the custom before making up new beds to fill in and ram up with small stones. In any case, when inspecting the state of the ballast, this should be tried over here and there by means of a pick and the work kept within strict limits until relaying takes place.

When the state of the foundation is examined, it is also necessary to see if the arrangements made for draining water away are efficient, and if and when it will be necessary to repair them. It is especially important to ascertain that there is no impediment to the free flow of surface water.

When it is found, however, that a more extensive cleansing is required, this as a rule is done before the general relaying as an independent piece of work, making special use of the best methods both from an economic and technical point of view.

Taking as a basis the result of the preliminary inspection of the state of the track, the supervisor of a section draws up a detailed programme for the year in which the work has to be done in accordance with the funds available.

This programme should include the exact amount of work required in each district, and contain a diagrammatic representation of the way it is proposed to make use of the gangs and to what extent casual labour may be required.

At the same time as he sends in his programme, the official in charge of this section of the track also furnishes a list of all material and tools required for the work, duly taking into account his own stocks. The material supplied to this order must as far as possible be conveyed to the spot without transhipment. Minor material (bolts, coach screws, clamps, etc.) must, without exception, always be placed under shelter.

As a general rule and wherever possible, the new ballast is conveyed immediately before the work is commenced, and dropped on one side of the line only, or in the six foot, according to the requirements of the loading gauge.

(*b*) Method by which general relaying, properly so called, is carried out.

The following system is generally adopted in the operations in connection with this particular work :

1. — Replacing in their proper posi-

tions rails and sleepers that have moved.

Removing the ballast to a depth of about 2 inches below the level of the bottom face of the sleepers in order to examine the state of the track, and especially that of the sleepers.

The ballast is removed by beginning at the side and continuing up to a distance of about 12 inches from the centre line of the track so as to form a sort of trough between the sleepers, and so allow any rain water to escape (see fig. 1).

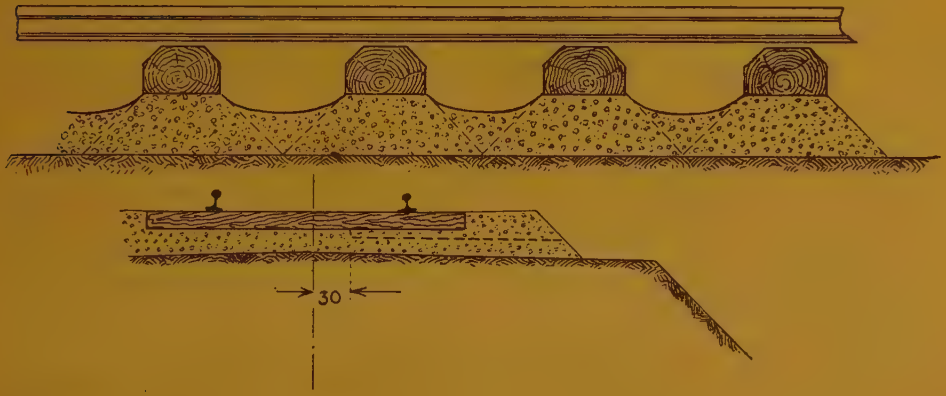

Fig. 1.

As a rule it is only necessary to do this between every other two sleepers, and it may be neglected altogether when it is found that the general condition of the track is good.

Replacing the component material of the track, such as rails and sleepers in bad condition.

When complete local replacement of the ballast is necessary, the defective sleepers are changed at the same time. These are fixed in their final position and rammed up with new ballast. (The systematic cleansing of the ballast according to requirements is only carried out in the third phase of the operations.)

Sleepers, the position of which has had to be adjusted (that is to say, when they have moved more than two inches out of position), must also be rammed up; and if at the same time it is necessary to adjust the rail level, these sleepers are subjected to an energetic ramming when being raised in the second phase of the operation. When the ballast has been cleared away in the first phase of the operations, it is allowed to remain provisionally in this state.

2. — Adjustment of the gauge and the angle of the rails. (When the screwing up of the joints does not meet the case, and the angle at which the rails are fixed is above the limit allowed, it is sometimes necessary to re-adze the sleepers and apply pitch to their supporting surfaces if this had not been done when the material was replaced in the preceding phase of the operations.)

Adjusting, trimming and levelling the track, especially the superelevation in curves.

3. — Cleansing the ballast between the

sleepers, as well as the exterior banking, according to requirements, and in order to ensure that the permeability of the ballast is good.

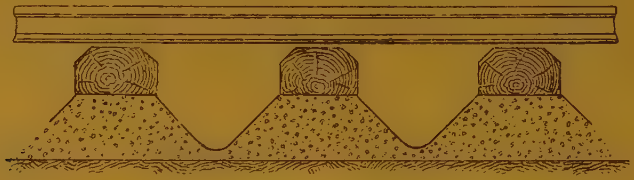

Fig. 2.

Screwing up the joints, final trimming of the track, and a second ramming of the new sleepers or the old ones that had become displaced.

Filling in and completing the ballast.

Supplementary work, such as clearing away scrapped material, cleaning ditches, banks, etc.

The Belgian State Railways, as a result of the satisfactory tests they have made, consider that the method of « shovel-packing » the sleepers is an advantage, especially as regards economy in labour.

To obtain really good results, however, it is necessary to have a good solid bed under the sleeper, and that it should be kept in scrupulously good condition. It happens, however, that this is not always quite satisfactory, as in cases where fine ballast is used such as ashes, fine gravel, sand, etc. The resistance of the bed varies not only according to the quality of the ballast, but also to its degree of dryness.

The time necessary to form a solid bed is evidently very variable, depending on the quality of the ballast. The size of the particles of ballast used in shovel-packing varies from 5 to 20 mm. (3/16 to 3/4 inch), and must be of a hard nature. (Sleepers placed on cinder or sand beds are shovel packed with cinders or sand.) Judging partly by their own experience, and partly by that of the French Railways, the Belgian State Railways consider that the cost of doing the work by this method is only half that of ordinary ramming.

The replies to the list of questions are insufficient to enable a definite opinion to be formed as regards this method. It is evident, however, that whether it be applied to ordinary revision work or general relaying, notable economies in labour are effected; and when comparing the advantages between wood or reinforced concrete sleepers and those of the trough type in iron, the comparison will be in favour of the first type, for which this method is only one that can be applied.

The result of the trials made in Belgium on the Bruges section shows that the work of shovel-packing sleepers may be stated as follows :

First of all the chief rammer and an assistant proceed to level the track and remove the material necessary to clear the supports that have to be raised. Following them comes the shovel-packer with his assistant, who raise the track by means of a lifting jack, and then commence the operation of shovel-packing properly so called, afterwards lowering the track to its seating. Finally, a workman proceeds to put all straight again, and when it is found necessary to cleanse the ballast between the sleepers, he is supplied with a man to riddle it.

The operation of shovel-packing the sleepers is therefore accomplished by means of a chief rammer assisted by four, or at the most five, workmen, shovel-packing being always done by the same man. For a distance of about 820 feet along the line a heap of fine ballast is placed, and the gang is supplied with a packing shovel, a wheelbarrow, a stretcher to carry the gravel, two lifting jacks, and the necessary shovels and picks.

If the superstructure and ballast are found to be in perfect condition, and the equipment of the track is such that it will be able to withstand the stresses required from it, and if the intervals between successive revisions have been exactly determined, it should not be necessary to institute any supplementary revisions except on chance occasions resulting from accidents. This ideal state of affairs does not exist, however, on all the lines, and in the interval between two revisions various defects in the superstructure occur, such as distortion, the repairs of which cannot be delayed until the next revision. As soon as these defects exceed the safety limit it becomes necessary to repair them at once, so that the security of the traffic may not be endangered, and this is done in the course of ordinary track repairs.

The method of general relaying is especially a seasonal one, that is to say, in order to give satisfactory results both from a technical and an economic point of view, it should be done in the most appropriate season of the year according to the climatic conditions of the country concerned. In the northern and central European countries, the end of spring and during the summer are the best times. Autumn in these countries is generally damp and less favourable for the execution of maintenance work on a large scale. When new beds of ballast are put down during the last months of autumn, it becomes necessary to build up these beds as a result of sinking or settling down during the winter, a time in which it is not possible to ram the sleepers on account of frost. During the winter the condition of the superstructure deteriorates, and at the beginning of spring is much worse, whilst occasionally the track shows signs of future distortion. Work in autumn cannot on account of the continual rain be so well carried out as in the dry summer season, also the shorter days have a marked influence on the quality and quantity of the work performed.

On the other hand, the most favourable period for doing this work is generally from the end of spring to the end of summer, when it should be stopped for a time to enable the new layers of ballast to consolidate. For this reason it is advisable to keep to a certain programme for the year's work, being guided by the principle that according to the climatic conditions the spring season, after the thaw has taken place, should be reserved for ordinary repairs. Maintenance work of greater importance, such as relaying, renewal of track, etc., should be reserved for the season chosen for this class of work. It is then that the greatest amount of work is required to the superstructure, generally necessitating an increase in staff for the purpose. When the work of the season is finished, the number of workmen is reduced to normal. On the other hand, the autumn season is given up to revision repairs, which are generally less important than those of springtime, their main object being to put the track in good condition before frost appears.

It is advisable, therefore, in order to obtain the best results from both technical and economic points of view, to work the two methods together, using the best part of each, and taking into account the degree of perfection required in the superstructure, the cost of labour, and the climatic conditions of each season.

The economic and technical results of the work depend largely on the organisation of labour.

In nearly all the replies which the railway administrations have been good enough to send us, the opinion is expressed that for normal and current maintenance work, local or normal gangs are made use of which entirely or chiefly consist of permanent workmen who are employed for the whole year. With some railway administrations the permanent workmen have a fixed wage like the permanent employees, thus differing from workmen employed casually, who are paid day work.

The latter are engaged according to the requirements of important work in hand, and are dismissed as soon as that particular work is finished.

According to the particulars sent in, the number of permanent workmen entirely occupied during the whole year ranges from 0.5 to 1.2 men per kilometre (0.8 to 1.92 men per mile), including the foremen of gangs.

An ordinary gang is generally made up of 4 to 7 men, who look after their particular section, the length of which varies according to the importance of the line. On main and branch lines this length is from 3 to 10 km. (1.8 to 6.2 miles), and on local lines it is longer. The length of a section in charge of a gang must not be too great, so that the supervision and control of the work is not too difficult, and in order to avoid loss of time in coming and going. At large stations, where work is more concentrated, a normal gang may consist of as many as 10 men if the upkeep of the track necessitates more frequent repairs.

The average number of men to provide per kilometre of track for *all* necessary work evidently depends on many local circumstances, such as the importance of the line, conditions relating to traffic, construction, etc., apart from the methods by which the work is done. For instance, for the upkeep of a single track of main line the Swiss Federal Railways require 0.7 to 1.3 men (1.12 to 2.08 men per mile); the Belgian State Railways, on an average, 1 man (1.6 men); the Italian State Railways, 1 to 2 or 1.5 men (1.6 to 3.2 or 2.4 men); the Danish State Railways, 0.8 to 1 man (1.28 to 1.6 men); the Dutch State Railways, 0.7 to 1 man (1.12 to 1.6 men); the Northern Railway of Spain, 1 man; the Portuguese State Railways, 0.7 man (1.12 men); and the Czecho-Slovakian State Railways, 1 to 1.5 men (1.6 to 2.4 men).

The average amount of labour per kilometre of line is generally simply decided by experience. For instance, the Danish State Railways estimate it is necessary to have on an average per kilometre (per mile):

For single track main lines, 0.8 (1.28) workmen;

For double track main lines, 1.3 (2.1) workmen;

For branch lines, 0.5 (0.8) workman;

For local lines, 0.4 (0.64) workman.

Some administrations calculate the average number of men on the basis of certain determining factors. For example, the Dutch State Railways arrange according to table No. 2.

The Czecho-Slovakian State Railways calculate their normal requirements of labour on the basis of *equivalent kilometres*, that is to say, kilometres of single track main lines which are straight and level, from which are calculated lines of greater or lesser importance as well as junctions, crossings, etc. The tables from which the equivalent length of track is found are arranged as follows :

1 km. (0.62 mile) of double track main line = 1 km. 500 (0.93 mile) of equivalent length;

1 km. of single track main line = 1 km. of equivalent length;

1 km. of local lines = 0 km. 500 (0.31 mile) of equivalent length;

1 km. of siding lines = 0 km. 330 (0.205 mile) of equivalent length;

1 km. of industrial station tracks = 0 km. 250 of equivalent length;

20 junctions = 1 km. of equivalent length, etc., of course taking into account the complications arising from the sections and gradients by increasing the proportional percentage.

Table No. 2.

NUMBER OF TRAINS PER DAY.	Double track lines.		Single track lines.		In stations.
	Number of workmen per kilometre (per mile) of double track.	Length of track, in metres (yards) per workman.	Number of workmen per kilometre (per mile) of single track.	Length of track, in metres (yards) per workman.	Length of track in metres (yards) per workman.
			Main lines.		
Less than 20. . . .	1 (1.6)	2 000 (2 200)	2/3 × 1 (2/3 × 1.6)	1 500 (1 640)	2 000 (2 200)
20 to 40	1.1 (1.76)	1 820 (1 990)	2/3 × 1.1 (2/3 × 1.76)	1 365 (1 492)	1 820 (1 990)
40 to 70	1.2 (1.92)	1 665 (1 820)	2/3 × 1.2 (2/3 × 1.92)	1 250 (1 367)	1 665 (1 820)
70 to 100.	1.33 (2.13)	1 500 (1 540)	2/3 × 1.33 (2/3 × 2.13)	1 125 (1 230)	1 500 (1 640)
100 and over. . . .	1.5 (2.4)	1 335 (1 460)	2/3 × 1.5 (2/3 × 2.40)	1 000 (1 100)	1 335 (1 460)
			Secondary lines.		
Less than 20. . . .	0.9 (1.44)	2 200 (2 406)	5/9 × 0.9 (5/9 × 1.44)	2 000 (2 200)	2 000 (2 406)
20 to 40	1 (1.6)	2 000 (2 200)	5/9 × 1 (5/9 × 1.6)	1 800 (1 970)	2 000 (2 200)
40 to 70	1.15 (1.84)	1 730 (1 892)	5/9 × 1.15 (5/9 × 1.84)	1 565 (1 711)	1 730 (1 892)
70 and over	1.3 (2.08)	1 530 (1 673)	5/9 × 1.3 (5/9 × 2.08)	1 385 (1 515)	1 530 (1 673)

To express junctions, goods lines and station lines to the equivalent of running lines, the following figures are used :

One ordinary branch or crossing	100 m. (110 yards).
One simple junction crossing	150 m. (165 yards).
One double junction crossing	200 m. (220 yards).
1 m. of goods track	2/3 m. (2 ft. 2 in.).
1 m. of important station line	1/2 m. (1 ft. 7 11/16 in.).
1 m. of less important station line	1/3 m. (1 ft. 1 in.).

The Railways of the German Empire base their figures for the amount of work per man on the average number of hours worked during the whole year. The annual hours required for each district are fixed either by calculation or according to the experience acquired during previous years.

These working hours are distributed over the whole year according to the importance of the work carried out in each month. For renewing the track a certain number of hours are fixed separately, evidently deducting those apportioned for normal upkeep.

Important work in track repairing, especially general relaying, as well as continued renewals of different parts of the track or complete repairs to the superstructure, which will be dealt with later on, is done by larger gangs than those normally employed, which are made up as follows :

1° Either of experienced workmen, that is to say, several normal gangs united to form a single one for the time being;

2° Normal gangs increased by workmen taken on temporarily, or

3° Workmen engaged temporarily.

From the technical point of view, the best results are obtained by the 1st and 2nd methods.

If, however, account is taken of the fact that the wages of permanent and experienced workmen are higher than those employed temporarily or casually, the 3rd method has a certain advantage from the economical point of view.

Many railway companies usually employ for repairing the track gangs composed of casual workmen in charge of experienced foremen.

For more important maintenance work, especially that of continued revisions, gangs made up of casual and permanent experienced workmen are employed, and finally, for less important upkeep work, the normal gangs.

The general arrangement of the work should be such that the number of supervisors are proportional to the number of workmen, that each man or ganger should know exactly his share of the work, that each workman should be given the task most suitable to his aptitude and be instructed how to do it, that one gang does not interfere with the working of another, etc.

Amongst the various operations, special work requiring a certain amount of knowledge and skill should be distinguished from elementary work that could be given to labourers.

In the first class of work for instance may be included the fitting up and repairing of the joints of the rails, laying sleepers, and especially fixing the special bearing plates, screwing up plates, adjustment of the gauge, re-adzing the sleepers, etc.

Workmen whose aptitude is taken into account do their portion of the work more easily, for example, some workmen are more adept in screwing and dealing with minor iron material, while others are more clever in the use of wood tools, drilling and adzing the sleepers, etc.

The transport of sleepers, rails, etc., and unloading ballast may be placed in the second category of work.

Casual labour may be employed for this class of work, or even workmen that are less skilled. The ganger should distribute the work to each man, and give him as far as possible that for which he is best fitted. The same workmen should always be entrused with special operations. Moving the gangs from one place to another, and changing the arrangements for distributing the work should be restricted to the narrowest limits, both for the gangs and the individual workmen. In order that the supervisor in charge may have proper control over the whole of the work, as well as minor operations, and be able to see that it is distributed evenly by the proper utilisation of each individual, it is necessary to maintain, during the whole time the work lasts, a clearly arranged distribution of labour, which can only be arranged by efficiently dividing the work into simple independent operations entrusted to each of the gangs.

This distribution between different gangs working independently of each other should not, however, be such as to stretch over too long a distance, as this would not only interfere with the proper supervision of the work, but would also adversely affect the running of trains.

The number of workmen engaged for very important maintenance work is fixed by the amount of time allowed for the job, as well as by the number that can be conveniently employed without interfering with the traffic. It is evident that the number of men required for continued revision must vary considerably. We gather from the replies form the various administrations that in general, with continued revision, gangs of 20 to 30 men are required, according to the state of the line. The daily output of work per man for an eight hour day is approximately 3.5 to 5 m. (11 ft. 6 in. to 16 ft. 5 in.) on the Italian State Railways, and 4 to 10 m. (13 ft. 2 in. to 33 feet) on the Northern Railway of Spain.

Special methods of working.

The results arising from the work when done are greatly influenced by the methods in use for each one of the detailed operations. If we only consider the general upkeep of the line, it will be seen that in the total number of operations there are quite a series of a special nature, for the accomplishment of which each administration adopts its own particular methods, consequently it is obvious that the technical and mechanical results obtained must vary considerably. The small amount of time we have at our disposal does not allow us to compare the results of these different methods of working, nevertheless we think it necessary to refer to the question, if only briefly, because it plays an important part in the economy and technical perfection of maintenance work.

For instance, one of the most common operations in maintenance work is ramming the sleepers, but from the particulars sent in by the different administrations, the way even this elementary work is done varies considerably.

Methods differ accordingly as the work is accomplished by hand or by the help of mechanically worked or other form of rammer, to the quality of the ballast, the kind of sleepers, and finally, if it is a question of ramming a sleeper newly laid or placing on an old bed with a view to maintaining or correcting its level, that is to say, only to adjust the bed of the ballast.

It remains to be seen which method of working offers the greater advantages, both from a technical and economic point of view.

The object of ramming is to obtain in a line with the rails and surrounding parts a uniform compression of the ballast below the sleepers which would ensure to the latter a fixed position for some time to come. It is with this idea in mind that each railway administration endeavours to make use of the best means for the purpose. The tools generally used for hand ramming are as follows: Beaters or iron picks, mattocks, spades, and ramming irons of different size and forms. Mechanical rammers are driven by electric motors or air machines working at a pressure of 60 to 90 lb. per square inch; or pneumatic rammers working with a slight pressure of air obtained by the motion of the piston in the cylinder.

The Belgian State Railways use the following method :

The preliminary packing is done by four men with shovels, and the final ramming by two men with the iron pick. One man successively rams points *a*, *b*, *c*, *d*, and the other man *a*′, *b*′, *c*′, *d*′, as shown on the sketch below.

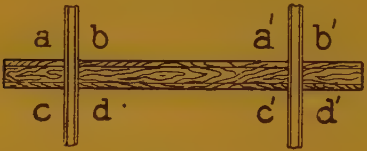

Fig. 3.

The first blows with the pick are given almost vertically in order to increase the cohesion of the ballast. The tool is then inclined more and more, until the last blows are given nearly horizontally. The hardest ramming is done near the rails, slacking off at the extremities and towards the centre of the track, but of course so that the ballast is not rammed under the middle portion of the sleeper.

On double tracked lines the sleeper near the joint in the running direction of the trains is most solidly packed. The men work without stopping at a particular sleeper until the ramming is finished, and the interval of rest is limited to the time necessary for the workmen to pass from one sleeper to another.

On the lines of the Northern Railway of Spain, the packing of sleepers is done by four workmen, who begin to work at the positions *A*, *B*, *C*, *D*, as shown below : and pack the sleeper from one side. They then change their positions to the other side, and work as shown at *A*′, *B*′, *C*′, *D*′.

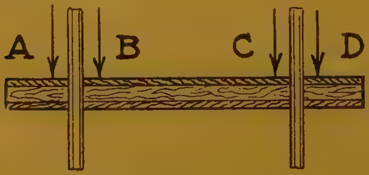

Fig. 4.

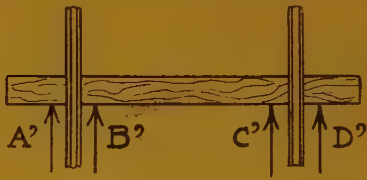

Fig. 5.

The packing is always begun under the rails and is continued either towards the end of the sleeper or towards its centre up to a distance of about a foot from the rail, the centre of the sleeper being left unpacked.

The Danish State Railways only employ gangs of two men when it is merely a question of levelling sleepers by manual labour in the ordinary course of upkeep of the track, or four men when the raising up is of greater importance and picks have to be used. When the ballast has to be renewed, the first manual operation is to raise the track a little higher than its exact normal position, and packing under the sleepers is proceeded with first with shovels. It is only after a few trains have passed over and so consolidated the layer of ballast under the sleeper that the pick is brought into operation, the sleeper being rammed first on one side and then on the other.

The Dutch State Railways and Norwegian State Railways use a method of working with four men, two being always on each side of the sleeper. Sometimes only two men are employed, who work first at one end of the sleeper and then at the other. To accomplish this the position of the men at the start is that shown on the sketch below at A and B, and the second phase at A′ and B′, so that the men face each other and both do their packing simultaneously.

The blows are given obliquely beneath the rails (fig. 6).

The Swedish State Railways generally use for the hand packing of sleepers groups of two workmen supplied with packing shovels. These men are placed face to face, and do their packing simultaneously. Only sleepers at the joints are rammed with the pick.

The Swiss Federal Railways make no distinction between wood, metal or concrete sleepers, or in the quality of the layer of ballast, and employ for hand packing four men who work simultaneously at each end of the sleeper, giving their blows alternately to time. The direction of the blows given beneath the rails is generally at an angle of 60° in relation to the centre line of the sleeper. After working a quarter of an hour, a rest of one or two minutes is allowed.

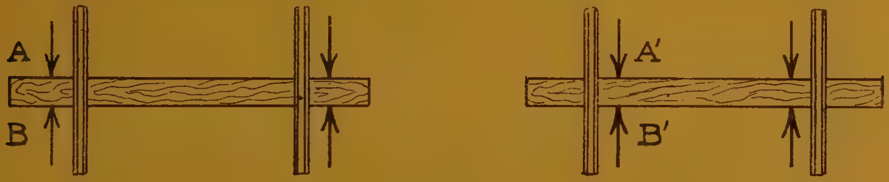

Fig. 6.

On the Czecho-Slovakian State Railways the custom for packing sleepers has up to the present been by hand. They are rammed up to a distance of 12 inches on each side of the rail, and as uniformly and carefully as possible.

When it is a question of a number of sleepers being packed on new ballast, as during the renewal of the superstructure or only the ballast, the packing is proceeded with in such a way that a settled number of consecutive sleepers, generally those carrying one or two pairs of rails, is apportioned to one gang of workmen.

When it is a question of a preliminary raising and packing of the sleepers and the time is short, the work is arranged as follows :

The track is raised a little above its normal position, and the ballast placed under the sleepers by means of shovels. Four men proceed then with the ramming, working first at the sleepers near the joint, and then at the intermediate sleepers at half and quarter lengths of the rail, then at the remaining intermediate sleepers, ramming up as shown in the sketch below. The packing and final adjustment of the track is then proceeded with. The final packing (according to the section) is arranged as follows :

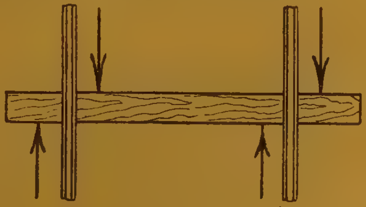

Fig. 7.

Each gang is composed of 8 men, 4 of whom work as hard as possible, while the other 4 continue the work after four or five minutes' rest.

This organisation makes the progress uniform, and allows the work to be done without interruption.

During the first ramming the blows are given as shown in figure 8, in the direction marked at *a*, *b*, *c*, *d*.

A given number of sleepers are packed in this way according to the length of the section, that can be dealt with between the passing of two trains.

After having packed all the sleepers and waited for the passing of a few trains in order to consolidate the bed, the second packing is proceeded with, during which the workmen change their positions and deliver their blows according to the arrows shown at *a'*, *b'*, *c'*, *d'* (fig. 8).

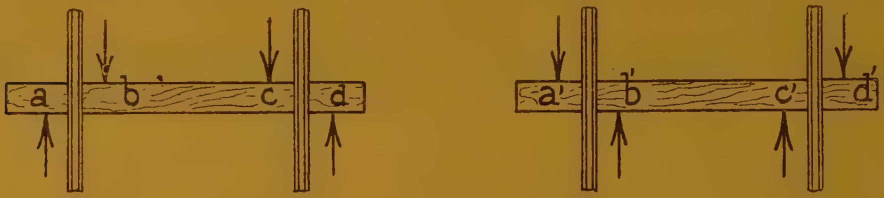

Fig. 8.

Generally speaking, the workmen ram the sleepers standing upright with one foot on the sleeper, keeping the other foot behind on the ballast between the sleepers.

It is important to watch that the workmen whose custom it is to work the pick with the right hand should as far as possible work on the right hand side of the rail, and that those who work more easily with the left hand are placed to the left of the rail, so that those who have to do the ramming may achieve their task more easily in the oblique direction.

Hand packing of sleepers that jump or have a loose bed of old ballast is done by first taking away the layer at the two bottom edges of the sleeper, then by means of a few strokes of the pick the top layer of ballast under the sleeper is filled up. The layer of ballast is then finished by being first of all rammed up in the central portion under the sleeper, and the requisite new ballast is then added, and finally successive ramming up over the whole of the sleeper is proceeded with.

The examples given of the different methods of ramming sleepers by hand show the necessity of studying this special form of work with some seriousness, not only from the point of view of the best mechanical means to economically carry out the work, but also from the technical point of view, taking into account the peculiarities of the superstructure. For instance, an opinion that has been confirmed after many years' experience is that ramming should be more carefully done under the rails, and its density should diminish towards the end of the sleeper and its centre, where evidently the ballast should not be rammed tight. Those sleepers placed at the joints, and more especially the one in the running direction of the trains, also the portion under the inside rail of curves, should be more thoroughly rammed.

This method, however, complicates the work, and any distortion that may occur in the superstructure does not altogether justify the practice, as the following reasoning shows :

It is known that the elastic sinking of the track is due on the one hand to the elastic springing of the sleeper, and of the layer of ballast immediately underneath it, which with a sleeper of soft wood and a ballast of small stones may amount to about 2 to 3 mm. (5/64 to 1/8 inch); and on the other hand to the gaps between the rails, sole plates and sleepers, as well as those below the sleeper. (If the attachments are made tight and the ramming carefully done, these gaps disappear.)

When the load comes on to the sleeper, the ballast is at first perfectly elastic, but after several loads have passed over, permanent distortion of the bed occurs, which brings about a uniform distribution of pressure along the seating of the sleeper.

In those cases where greater pressures occur, the ballast gives way more readily than at spots where the pressures are less, so that in a short time an equalisation of the pressure takes place, simultaneously with the distortion of the surface of the bed of ballast on which the sleeper lies. This surface — or bed of the sleeper — is at first flat, but later takes the form of the elastic shaping of the loaded sleeper. The bottom face of the unloaded sleeper forms a surface in contact with its bed at three points — the ends and in the centre of the sleeper. When the load is applied, this surface is identical in shape with the bed of the sleeper on which it always lies, the pressure being uniformly distributed.

Admitting this action of the layer of ballast, it should be worth while trying to find out if there is an advantage on account of the uniform elastic distortion and the homogeneity of the track, to ram all the sleepers with equal intensity, and always as carefully as possible in such a way that each sleeper is packed under the rail and to a distance of 25 cm. (10 inches) on each side of it, and to the same degree of compactness, thus simplifying the ramming process.

Also in other detailed operations which occur in track maintenance very varied methods are used, which greatly influence both the technical and economic results.

The natural consequence of this variety of methods brings about the necessity of finding the true value of each one of them according to results, both from the technical and economic points of view, on the basis of systematic observation, in the same way that the different systems of construction and laying down the superstructure are arrived at by means of studying the question experimentally, and by tests and observations made on those tracks under trial.

Some railway administrations make a point of placing the various systems of superstructure under systematic observation so as to ascertain their respective values as regards the resistance of the material, its stability, and the amount of upkeep it entails. The results of these observations and experimental tests bring about an appreciable improvement in the methods of arranging how the work should be done.

It is advisable also to include a systematic examination of the various kinds of tools and methods employed in the upkeep of the superstructure, both from the technical and economic points of view, as well as of efficiency.

As far as we are able to judge from the particulars sent in, it does not appear to us that this subject, which is so important as far as technical and economic results are concerned, has received all the attention it most certainly deserves.

CHAPTER II.

Methods in use for renewing the superstructure.

The necessity for renewing the whole or a portion of the superstructure occurs when :

A) Wear or certain defects have reached such a point that the resistance of the superstructure to strains may in the near future be seriously compromised, or when the security of the traffic on account of these defects necessitates, from the economic point of view, such expense that the repairing or the complete renewal of the superstructure or its constituent parts appears to be the most rational method;

B) When it is necessary to strengthen the track;

C) When it is necessary to procure material, rails for instance, that has become obsolete for this class of track, with the view of using it again on other lines of less importance.

The necessity for renewing ballast occurs when it has lost its permeability, and there is no advantage in improving it by sieving.

Sleepers have to be changed when they have become so weakened by cutting away their bearing surfaces that have become split or rotten, especially the part under the rail, and when the coach screws, cramps, etc., no longer hold. The homogeneity of the track changes by local replacements of sleepers, so that at the end of a certain time sleepers are found in the track having a different solidity and elasticity from others. The replacement at the same time of all the sleepers in a chosen section of track has the advantage of re-establishing the homogeneity of the latter. The necessity for replacing all the sleepers generally occurs when it is found that more than 50 % are no longer fit for service.

Rails reach the end of their life on main lines when the wear has reached the limit allowed, or when interior defects have become manifest by frequent breaking, etc.

The life of the principle parts of the superstructure depends on the quality of the material, the loads they have to carry, and the local conditions of the lines. This period is very variable. Ordinarily the wear shows first at the ballast, then in the sleepers, and finally in the rails.

As regards material that has to be replaced, we may in principle mention four kinds of complete renewals that occur in practice :

a) Renewal of sleepers;

b) Simultaneous renewals of sleepers, rails and minor material (general repairs to the track);

c) Renewal of the ballast;

d) Complete renewal of the superstructure (rails, sleepers and ballast).

By systematically keeping the superstructure in repair, especially by the method of continued revisions, the life of the elements constituting the track is lengthened, and the necessity for their renewal may be considerably reduced. Replacing sleepers and rails generally takes place at the general relaying, where this is practised, so that the renewal of sleepers or rails only happens occasionally when wear has reached the limits allowed.

In the case of renewing sleepers (section *a*), it is necessary to partially remake the ballast bedding, taking into account the difference in height between the new and the old sleepers.

As it is, however, generally absolutely necessary to readjust the position of the sleepers, and also when desirable to increase their number, which means a redistribution, it becomes necessary on account of this change to make a new bedding of ballast for such sleepers. It is undesirable to place new material on the old bed. It is as a rule in such cases necessary to renew the ballast and also the beds under the sleepers in a relatively short space of time. For this reason a complete renewal of the latter is not economical except in special cases.

The simultaneous renewal of the sleepers and the rails with the minor material (section *b*) usually only occurs when it is necessary to lay down a stronger track, or when it is necessary to recover material that is no longer manufactured, in order that it may be used at other places.

Renewing the track according to method *b*, would neither be economical nor correct from a technical point of view without a thorough cleansing of the ballast at the same time.

Consequently the most rational method is that explained in section *d*, that is to say, by a complete and simultaneous renewal of the whole superstructure, of course using again the old ballast after it has been taken up, cleansed, and the necessary amount of new ballast added to it.

In addition to this complete renewal of the superstructure, it is after a certain time necessary, according to the state of the ballast, to proceed with its general renewal as mentioned in section *c*, which as a rule occurs oftener than the necessity for replacing sleepers and rails.

We may add, in order to make our report complete, that taking into consideration the intimate relationship between maintenance work and the running of the trains, it is also necessary in principle to consider two methods relating to the organisation for the renewal of the superstructure, namely :

I. — With interruption of the traffic;
II. — Without interruption of the traffic, but taking advantage of the interval between the running of two trains.

In the first case, which is generally applicable to double lines, the portion to be repaired is closed, and the traffic is worked on the other line as on a single track; or the siding or loop line which has to be renewed is closed to traffic altogether during the period of reconstruction. If we consider only work done on an ordinary track, this method — closing one track during the period the superstructure is being renewed — is only advantageous from the fact that the work advances more rapidly. From the economic point of view it is not always the best, on account of the necessary restriction of traffic.

When there are no imperative reasons, such as work in tunnels, it is generally advisable to use the second method, that is to say, without altogether closing the track, the principal reason being that the running of the trains is not interfered with, and their circulation contributes to the consolidation of the ballast bed.

The method of closing the track is adopted on the Belgian State Railways for their double lines. Temporary crossover lines are placed at each end at the nearest stations, and as soon as the daily task is done the normal traffic is resumed on both tracks until the next day. If total renewal of the superstructure of the track has to be considered without permanent interruption of the traffic, that is to say, according to system II, the following methods of working may be used :

1° After taking up the old track, the new one is laid down directly along its centre line in its final position, using material prepared on the spot;

2° The new track is put together with material prepared by the side of the old track; then after removing the latter the new one is definitely slewed into position; or portable sections of the new track are put together along the old superstructure and slewed one after the other into their final places;

3° Each of the different parts of the superstructure, such as rails, sleepers and ballast, are put back separately.

The method of working in renewing the superstructure depends largely on the length of the intervals in traffic, on the arrangements made for a sufficient number of workmen to be present, and local conditions, especially if it is possible to put together the portable sections without much difficulty or cost by the side of the old track, etc.

It is of course understood that the supply of material must be arranged beforehand, so that when the work is commenced that which is necessary, together with the tools and appliances, shall be ready on the spot.

The Belgian State Railways generally use the first method, and the Norwegian State Railways the third.

Before the war, the Dutch State Railways generally renewed the track at night time, during the long intervals between the passing of trains, and on double tracked lines during the stoppage of traffic on that track being renewed. At present, however, the work is done by placing a certain number of rails by the side of the track, and during an interval a number of old rails are taken up and the new ones placed on the old sleepers, these being then changed one after another. By this means no reduction of the speed of trains is necessary. When the new track differs from the old one, the renewal is accomplished by putting new sleepers between the old ones and then placing the rails on them so that the centre line of the new track is on one side at a distance of about 10 inches from its final position. As soon as a section of line ranging from 650 to 1 000 feet in length has been laid in this way, the old track is cut, and the portion of the new track that is ready is connected up at the two ends during suitable intervals in the running of trains. The detached portion of the old track is removed, and the new one is slewed into its final position.

The gang is composed of 30 workmen, and their daily work amounts to 2 m. (6 ft. 7 in.) per man.

The Danish State Railways have adopted the following method when renewing tracks :

a) The old track is moved to about 8 1/4 inches from the centre line. All joints are adjusted in the curves;

b) All the sleepers at the joints, as well as those that have been condemned, are changed for new ones, and the latter with about half the old ones are placed as nearly as possible in the position they will definitely occupy in the new track. The old rails are then fixed temporarily on these by means of cramps, each rail having two cramps for each sleeper;

c) The new rails are placed in their final position, that is, about 8 1/4 inches from the old ones;

d) The fishplates are then fixed;

e) The sole plates are placed under the new rails and fastened to the sleepers in their final position, and the new rails are fixed temporarily by cramps to the other sleepers;

f) The old track is cut and the new one joined up, after which the former is taken away and dismantled, the remaining sleepers which have not yet been definitely fixed in the new track are put in their proper positions, the level of the track is adjusted, and the sleepers are rammed.

The number of men in the repairing gang depends partly on the possibility of being able to provide a large number at the spot where the work is done, and partly on the method by which the latter is accomplished, which depends greatly on the intensity of the traffic on the section concerned. The total number of workmen varies generally between 25 and 40, distributed in different groups.

Groups of 4 to 6 men are employed on preparatory work such as removing the ballast, unscrewing bolts in the old track, laying down the joint sleepers and a few intermediate sleepers for the new track, and the distribution of the new material required, etc. In addition to these, other groups are formed as follows :

14 to 20 men for renewing the rails, etc.;
10 to 20 men for renewing the sleepers;
8 to 10 men for adjusting purposes;
5 to 10 men for gathering up worn material.

It should be pointed out that all these groups do not work simultaneously, but that workmen who have been engaged one part of the day in renewing rails, may be used later in the same day on renewing sleepers or taking away worn material.

The average speed at which relaying is done generally varies between 2 and 3 lineal metres (between 6 ft. 7 in. and 9 ft. 10 in.) of track per day per man.

Continued repairing of the elements of the track separately is less efficacious than simultaneous relaying. New rails fastened to old sleepers, even provisionally, suffer from premature distortion. For the same reason it is not advisable to fix new sleepers on old ballast without cleansing the latter.

In the interest of the life of the sleepers, it is generally best to place new sleepers on new ballast, or on ballast that has been well riddled.

The Italian State Railways are of opinion that the first method (building up along the centre) is the best from the economic point of view. With this method 110 yards a day may be done with a gang of 30 to 40 men, including repairs to the ballast.

With the method of building up the track at the side the same amount of work would require a gang of 40 to 55 men.

The Swiss Federal Railways make most use of the method of renewing the superstructure, which consists of entirely demolishing the old one and building up the new track along the centre line, using for this purpose gangs of 40 to 50 men. The daily result varies a great deal. For instance, in tunnels it amounts to about 0 m. 60 (2 feet), in the open to 0 m. 70 (2 ft. 3 in.), and on secondary lines to 1 m. 30 (4 1/4 feet) per workman par day.

In exceptional cases where traffic is heavy, the repairs are done bit by bit.

The process of renewing the superstructure on the Northern Railway of Spain consists of first taking away the old ballast and riddling it, leaving only the layer remaining under the sleepers. A number of the fishplate coach screws and bolts are then removed, so that only one bolt remains on each side of the joint. After the passing of the last train the other fastenings are taken away from the rails and sleepers for the length of the section to be renewed during the train interval. The remaining ballast is then taken up, and after levelling the foundation, the first layer of new ballast is put down, on which the sleepers, sole plates, and finally the rails are placed, and the new track is fixed centrally. The sleepers are then rammed, and the top layer of ballast is placed above the level of the beds of the sleepers.

The number of wormen engaged in this renewal of the superstructure averages 50, and the daily amount of work per man is about 2 m. (6 ft. 7 in.).

The Czecho-Slovakian State Railways use the first method (building the new track along the centre), as well as the second (building the new track by the side of the old one), according to local conditions.

The diagrammatic distribution of the work in these two cases is as shown as follows :

A. — Preliminary work.

Setting out, unloading material, placing material where required, fixing the sleepers, and finally mounting the portable section alongside the track, etc.

B. — Operations connected with the work properly so called.

a) *Work done before cutting the track.* — In this category is generally included clearing the track, removing the ballast between the sleepers, riddling the ballast, removing minor material such as bolts, cramps, and coach screws as far as the safety of traffic at a reduced speed allows, and generally all the preparatory work for the cutting process, such as greasing the joint bolts with the object of releasing the fishplates, etc. This is all work done to the old track.

b) *Work during the cutting process.* — First the old track is removed and the old bedding of ballast broken up, then the new track is placed in position, finally fixing in place the new portable sections of the track built up on the side of the line, laying the ballast, and provisional ramming of the sleepers, etc.

c) *Work after cutting is done.* — In this category is generally included important rectification of the level, adjusting and trimming the track, and ramming the sleepers.

C. — Complementary work.

Final ramming of the sleepers, and final levelling and straightening up the track. Taking apart the old sections of the track which had been slewed aside, if the breaking up of the old track had not already been accomplished during the previous operation, loading up, transport and unloading of the scrapped material. Clearing away the remains from the sieving of the ballast, and re-establishing the section of the track. Cleaning the footpaths and ditches. Sorting out material not required, and various other complementary work of less importance.

The rapidity with which the work is done depends chiefly on the appropriate utilisation of the whole of the interval allowed during the cutting of the track. In order that the work done during period *b* can be proceeded with rapidly, it is necessary that during period *a* as much of the preparatory work as possible

Diagrammatic distribution of the work.

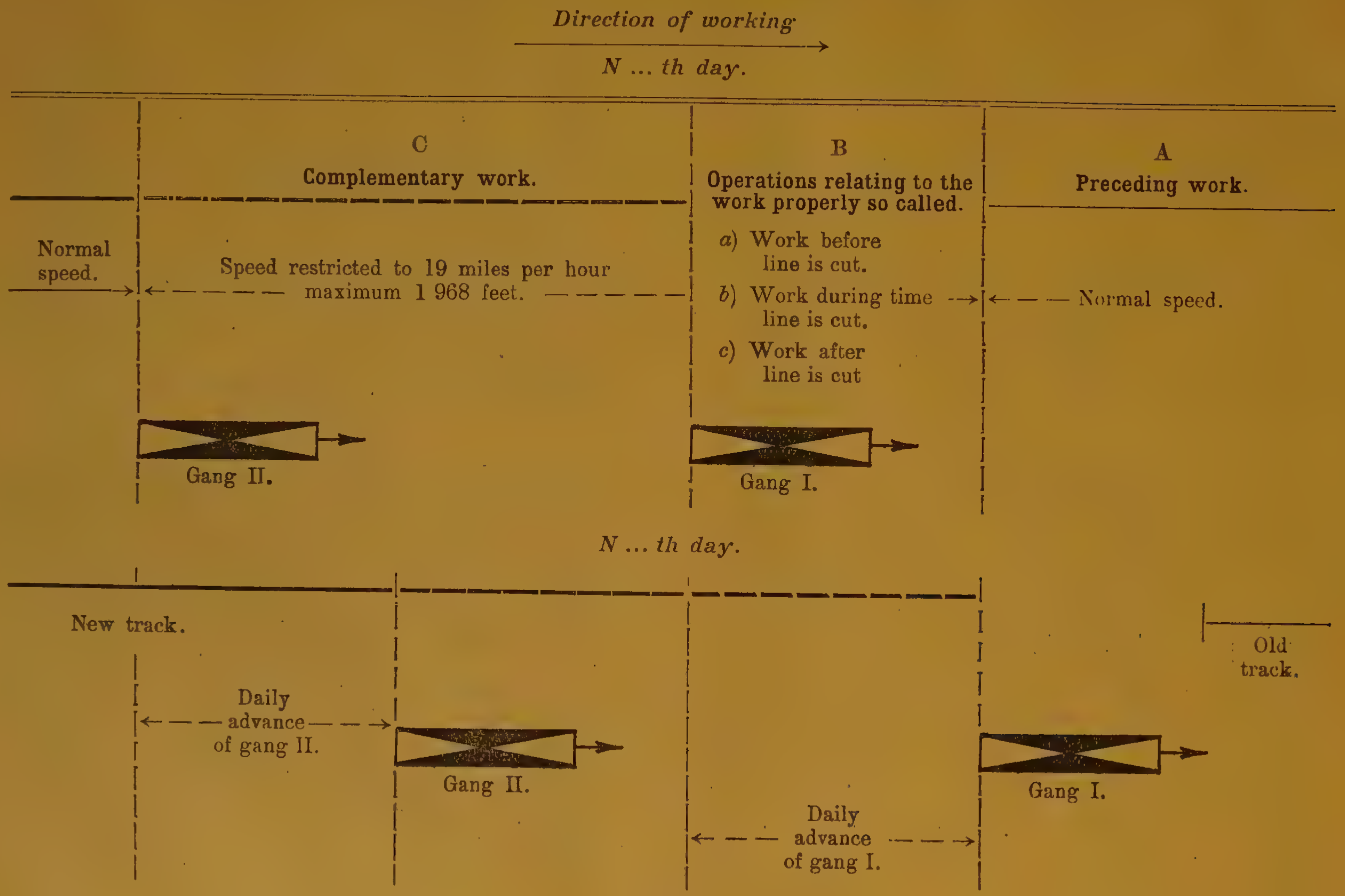
Direction of working
N ... th day.
C
Complementary work.
B
Operations relating to the work properly so called.
a) Work before line is cut.
b) Work during time line is cut.
c) Work after line is cut
A
Preceding work.
Normal speed.
Speed restricted to 19 miles per hour maximum 1 968 feet.
Normal speed.
Gang II.
Gang I.
N ... th day.
New track.
Old track.
Daily advance of gang II.
Gang II.
Daily advance of gang I.
Gang I.

Fig. 9.

should be done, so that when the cutting takes place in the *b* period it is possible to finish, before all other work, that which can only be accomplished during the last period.

This means that all preparatory work should be finished before the arrival of the last train preceding the commencement of cutting. Immediately before the arrival of this train, the workmen are gathered together in sufficient number in section « B », and are formed into gangs, according to the exact distribution of the work, each being in charge of a ganger. Everything should be so prepared that as soon as the last axle of the train has passed the section to be renewed, the work may be commenced at once. The chief man in charge watches that the work is judiciously distributed, for on this depends the technical and economic result that should be obtained.

The amount of experience the foremen have had, and also that of each of the workmen, has a marked influence on the amount and speed of the work done. Some of it requires a long time in which to become proficient, as for instance, adjusting the gauge, fixing the joints, adzing and shaping the sleepers, connecting up provisionally, fitting fishplates, drilling and ramming the sleepers, etc.

Other simpler operations are given to inexperienced workmen, whose efficiency is less at first, but improves as they become better accustomed to the work.

Those in charge also (gangers and district supervisors) only acquire a practical knowledge of what a well-ordered organisation of the gangs should be in course of time, especially after having had experience with the most economical methods. As regards this the following circumstances should be borne in mind. Repairing in any particular district takes place generally after several years. The supervisors of the work are usually district foremen who, having to make all the arrangements, are often for the first time placed in this position, or if they have done it before, a long interval may have elapsed.

As a general rule these men only become thoroughly conversant with the work when it is about finished.

In order to obtain an efficient organisation, and at the same time a bigger output of work from the beginning, it is advisable that in more or less extensive districts supervisors should be engaged who have specialised, and who have had a good practical experience as regards organisation in this class of work. They would naturally see that it is done in accordance with the best known methods, or at least make all the necessary arrangements for the work to be afterwards taken in hand by the foreman responsible for the local district. This supervisor should see from time to time how the work is progressing, making use of the results obtained to successively improve the methods by which it should be done.

In order to show the importance of organisation in these big undertakings, we think it necessary to give a more detailed example, and will briefly explain the most general method, as well as the organisation employed on the Czecho-Slovakian State Railways when completely relaying the superstructure by method I — that is to say, by building up the new track directly in its final position.

As regards « A » :

A well furnished depot of material has a very beneficial influence on the procedure of the work referred to above.

In principle the new ballast is laid on

one side of the track, whilst on the other side the space is left free for cleansing the old ballast. Room is prepared along the track that is to be renewed for the deposit of the necessary ballast for the first layers of the new track.

On single lines the old ballast is removed from between the ends of the sleepers and the banking to the depth to which the new ballast has to be placed.

The banking, so far as it is above the new foundation, is levelled down to it, and the latter is made to the desired slope.

The ballast in this region is cleansed, chiefly with forks, and piled against the ends of the sleepers.

At the edge of this banking a small enclosure is made of old planking, and on this arrangement the new ballast is deposited on which the new rails and sleepers are laid (fig. 10).

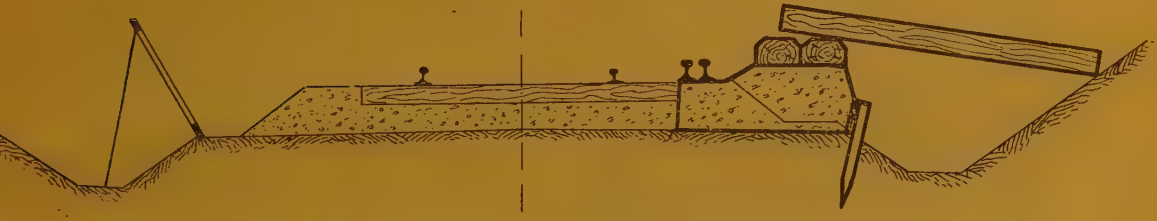

Fig. 10.

When working on double lines, the new ballast is placed in the six-foot. With this object in view the old ballast between the ends of the sleepers and the six-foot, down to a depth of about 10 cm. (4 inches) under the sleepers, is removed, and the new ballast is laid so as not to interfere with the loading gauge.

The rails are always laid down one by the side of the other on the layer of ballast intended for the other track, leaving place for the old rails when these are changed over. The sleepers are deposited on the side banking of the other track, and are distributed along each of the pairs of rails. The sleepers intended for the joints are specially chosen, and placed with their ends facing the run of the track, with the appropriate number of intermediate sleepers lying between them (fig. 11).

Minor material is stored as far as possible near the linemen's huts.

As regards « B » :

a) Work before cutting the line.

The day before the cutting takes place, the ballast is removed down to the bottom edge of the sleepers. This is done by means of forks, by which the ballast is cleansed, and thrown on the new ballast lying between the tracks or on the bank. Before the cutting takes place, on the same day that the track is to be renewed, the ballast in the old bed is removed to a depth of 8 inches on main lines, and 6 inches on secondary lines, below the future bottom face of the sleepers, so that only the bed of the old layer on which the sleepers lie is left.

During this operation, if the ballast

is found sufficiently good, it is cleansed by means of forks, and thrown on the ballast deposited between the tracks or on the banking. The remainder of the ballast is thrown on sieves fixed at the side of the foundation of the track, so that the cleansed ballast may fall on the side banking, and any earth residue on to the slopes or into the ditches. When the old ballast has become thoroughly bad in quality, it is formed into a heap, loaded up with shovels, and sent away.

During the preparatory work, the exact position of the new joints must be staked out by the marking out staff, which is as long as the new rails, and the measurements are taken from the head of the old rails.

For each measurement taken with this rod allowance is made for the expansion corresponding to the temperature of the air, and each joint is placed at its correct level by means of a stake.

For each new pair of rail sections, three fixed levelling points are determined in the following way :

The exact positions of three sleepers are fixed (two of which are at the joints, and when possible the two adjacent joint sleepers as well as an intermediate one), for each new pair of rails. The exact positions of these three sleepers in each pair of rails is fixed by the use of wooden supports fixed in such a way that the sleepers placed on them occupy approximately the exact position as regards level in relation to the run of the new track (figs. 12 and 13).

The supports 6 or 8 inches thick, 9 1/2 inches wide, and 19 3/4 inches long are placed horizontally on the foundations, so as to make certain of the required slope of the foundation of the track. The inclined position of sleepers on curves is adjusted by means of wedges.

About one third of the fastenings are removed from the section of track which is to be renewed during the course of the same day. The joint bolts are soaked with paraffin and loosened, and half of these bolts are screwed up. The spaces left for expansion are fixed according to the surrounding temperature.

The joining up of the new track to the old one is done with a few rail cuttings of different lengths.

In order to obtain this jointing, special fishplates are provisionally used (when the rail heads are of unequal height) between different sections of rails, as well as a few lengths of the type of rail that is to be replaced from a choice of 16 pairs, the lengths being 3 m. 50, 3 m. 55, 3 m. 60, 3 m. 65, 3 m. 70, 3 m. 75, 3 m. 80, 3 m. 85, 3 m. 90, 4 m., 4 m. 50, 5 m., 5 m. 50, 6 m., 6 m. 50 and 7 m. (11 ft. 6 in., 11 ft. 8 in., 11 ft. 10 in., 12 feet, 12 ft. 2 in., 12 ft. 4 in., 12 ft. 5 5/8 in., 12 ft. 7 5/8 in., 12 ft. 9 9/16 in., 13 ft. 1 1/2 in., 14 ft. 9 in., 16 ft. 5 in., 18 ft. 9/16 in., 19 ft. 8 in., 21 ft. 4 in. and 23 feet).

By this method it is not necessary to divide the rails up and use temporary fishplates with oval holes. When the difference of level between the two rail ends is not entirely compensated for by the provisional connection, a pair of lengthening pieces 3 m. 75 (12 ft. 3 1/2 in.) long are introduced, made from rails of the same kind as the new ones, in order to protect the head of the new rail on the provisional joint from hammering effects. (To do this one of the shorter rails is sacrificed and made into two, for instance $\frac{7\text{ m. }50}{2} = 3\text{ m. }75$).

These cut portions are joined together

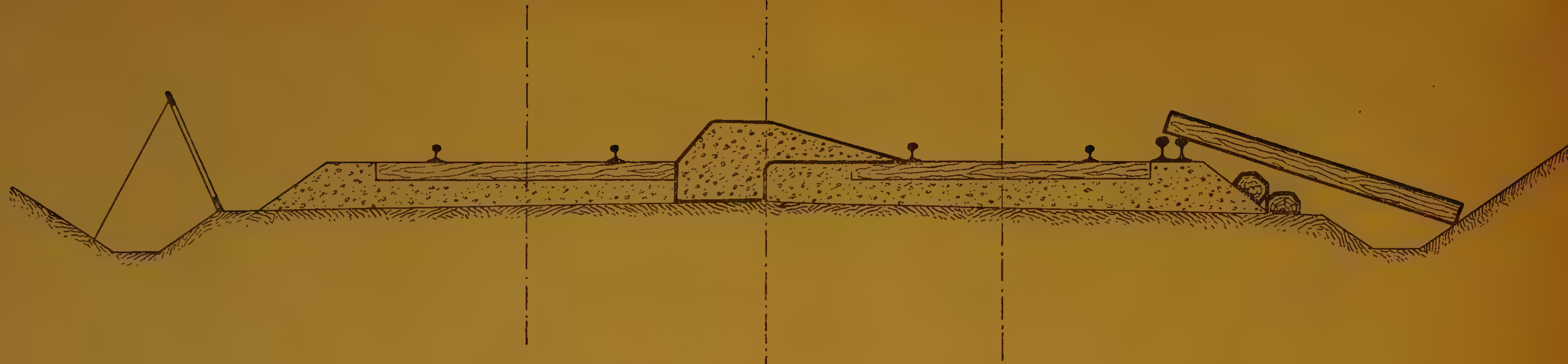

Fig. 11.

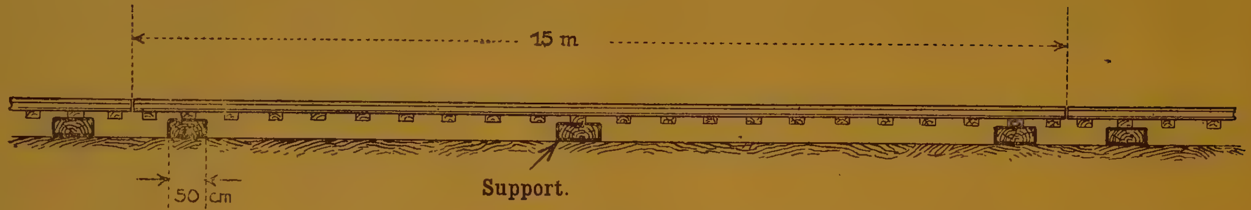

Fig. 12.

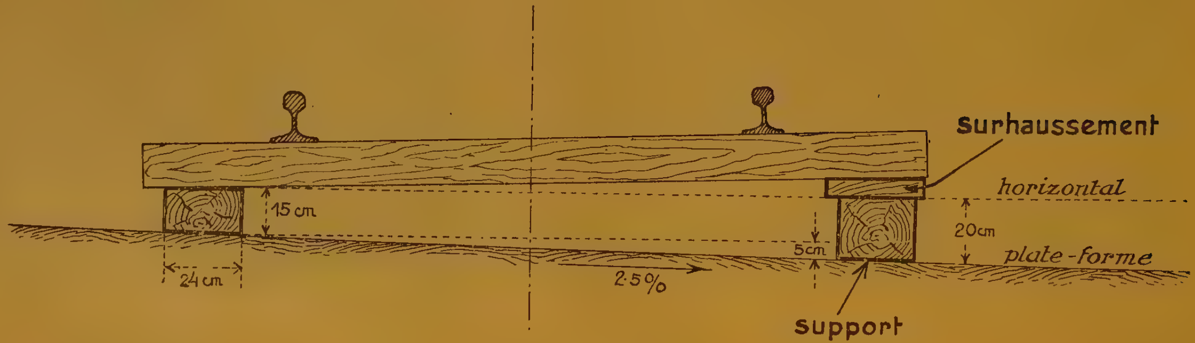

Fig. 13.

Translation of French terms; Surhaussement = Superelevation. — Horizontal = Level. — Plate-forme = Foundation in a permanent way with the special fishplates, and conform always with the succeeding provisional joint, so that it may be in use during the whole of the period the superstructure is being renewed.

b) Work during the time the track is cut.

Organisation of the work during this period is in principle of two kinds, either according to the grouping system, or to the system based on the specialisation of the working gangs.

The first method consists in distributing the workmen who are to lay the track, except those appointed to join up the new track to the old one (4 to 5 men), into identical gangs.

Each of these gangs takes over all the work that is to be done over a fixed length of the new track. For instance, if 15 m. (49 ft. 2 1/2 in.) rails are laid down each of the gangs has for its portion three pairs of rails (45 m., 147 ft. 7 1/2 in.) to attend to. In case the interval between trains is shorter, the section is reduced proportionally to 30 m. (98 ft. 5 in.) and even to 15 m.

As soon as the last train before the cutting passes, the section is protected according to the signal regulations, and the neighbouring stations are informed by telephone that the line is cut.

For example, when advantage can be taken of closing the track for an interval of four hours, it is possible to deal with a section of three pairs of 15 m. (49 ft. 2 1/2 in.) rails, in all 45 m. (147 ft. 7 1/2 in), employing 21 workmen.

The sequence of the work is distributed among these groups as follows :

1° Unfastening the old joints, and removing the cramps and coach screws on one side of the rails;

2° Turning over and removing the old rails, which are then placed on one side;

3° Removing the old sleepers;

4° Breaking up the bed and preparing the foundation, taking into account the laying down of temporary supports;

5° For each pair of rails three new sleepers fitted with soleplates are placed on the supports prepared for them as nearly as possible in the line of the new track. The other sleepers ready with fittings are placed on the foundation;

6° The new rails are placed on the sleepers which are lying on their supports, and are fixed in position;

7° Fishplates are fixed to the new rails, and the joints are fitted with expansion wedges. (As soon as the rails have been connected, a specially equipped gang joins them up to the old track by means of the fittings previously used);

8° The sleepers lying on the foundation are raised and attached to the rails;

9° Ballast is thrown on the track, and forced under the sleepers;

10° The wooden supports, which till now had held up the track in position, are taken away;

11° The sleepers are rammed. Adjusting the level and finish of the new track, as well as the connection to the old one.

By this method of arranging the work the rapidity with which the new superstructure can be laid depends on the quality of the labour that can be used.

For instance, given 6 gangers and 114 workmen (5 gangs of 21 each=105, to look after the joining up, signalling, and putting together minor material, 9, 105 + 9 = 114). 5 × 45 m. = 225 m. (245 yards) of superstructure replaced in a 4-hour interval between trains.

In making use of this system the specialisation of the various operations is also carefully arranged in this sense, that when there is a repetition of the work, each of the gangs is formed of the same men to take charge of the special operations they are most accustomed to. For instance, the work of fixing the new joints is given to those workmen who had previously unfastened the old ones.

Generally the workmen have various duties to perform, that is to say, sometimes they take up and bring along the rails and sleepers, then dig out the beds, throw in the ballast, and ram the sleepers, using alternately various tools. These tools should be placed ready in the proper position for each of the gangs, and in a relatively greater number than that required by the second system.

This second process depends on specialisation of the work, the workmen being occupied from beginning to end of the operations and as long as possible on one class of work only.

Before the cutting operations begin, the workmen are divided into gangs to which is apportioned the work they are entrusted with.

One gang then unfastens the joints, and removes the cramps and coach screws on one side of the rails.

A second gang turns the rails over, removes them, and either loads them upon lorries or places them on one side.

A third gang clears away the old sleepers. When it is necessary to remove to one side the entire frame-work of the old rails that has not been dismantled, the two last mentioned gangs are formed into one.

Another gang digs out the old beds and removes what remains of the old ballast, straightens the foundation, and fixes the sleepers (three for each pair of rails) on the temporary supports.

Another gang (similar to the second) brings along the new rails and places them on the sleepers lying on the abovementioned supports.

Another gang (similar to the third) brings up the new sleepers, places them on the foundation, and as soon as the rails are fixed, fastens the sleepers to them. Then when the preceding gangs have finished their respective tasks, they commence laying the ballast and ramming the sleepers.

A small special gang takes in hand the joining up of the new line to the old one.

This system requires fewer tools than the first, and it is also easier to supervise. Loss of time is less important, because it is possible to begin the work uniformly over the whole length of the section of operations, so that the workmen may be fully occupied from the commencement. By the second method, to the contrary, the work is begun at one end and continues to the other end of the section that is to be renewed during the time the line is cut. The result is that from the commencement, and before the work is properly started, certain losses of time occur, because all the men cannot be engaged all at once at their respective tasks, some of them being obliged to wait until the preceding gangs have got on with their work and are able to give room to those which follow.

The first system refers principally to the moving of workmen perpendicularly to the run of the track, and consequently a shorter distance than by the second method, which mostly necessitates this moving to take place in a longitudinal direction.

Supervision of labour is easier by the first method, as the ganger has greater control of his men, who are fewer and confined to shorter spaces.

The first method is especially to be recommended where long sections of track have to be repaired, and the interval between the running of trains is long.

It is advisable to do as much as possible of the work just before the line is cut, because during this period it is accomplished with greater energy.

For this reason, for instance, it is best as far as possible during this same period to proceed with the dismantling of the old track, which from an economical point of view is sometimes preferable to removing pairs of rails and only taking them apart after the line is cut.

The speed of the last train before the line is cut, as well as that of the first train running on the new track after, is in exceptional cases reduced to 6 1/4 miles per hour. Generally speaking the trains are allowed a speed of 19 miles per hour when the work is at the point B and C.

c) Work after the line has been cut.

Immediately after the line has been cut, and on the same day, the track is put into as perfect a state as possible. Trimming and levelling are adjusted by means of the stakes, the sleepers are well rammed, and their ends are fully supplied with ballast, especially on the exterior side in curves.

As regards « C » :

This period of doing the work follows the preceding period at the end of a certain number of days, varying according to the frequency of the trains and the quality of the ballast influencing the consolidation of the beds, so that the newly laid track may be run over at least 50 to 100 times by heavy trains. During this period the work is undertaken by a special gang.

The distance between gangs I and II (see fig. 9) must not exceed 660 yards, and the work apportioned to this period is distributed approximately in the order shown in the preceding scheme.

When the work relating to the superstructure is finished, it is submitted to a careful inspection, and after any imperfections that may have been discovered are rectified, the relaying may be considered finished.

At the end of about three months, generally in autumn, another inspection is made of the section of track that has been renewed, and any irregularities found are rectified, especially loosening of the sleepers, sinking at the joints, etc.

When on double tracked main lines the time the line is cut amounts to about four hours (with 8-inch layer of ballast under the sleepers), working with the permanent staff, the daily amount of work done with the above mentioned organisation averages 11 to 12 working hours per metre.

This figure allows 45 % to the preparatory and other work before cutting, 25 % to the work during the time the line is cut (approximately 2 m. [6 ft. 6 3/4 in.] per man), and 30 % to the work after the line has been cut, including complementary work.

In case 2, that is to say, the gathering together of the new rail framework by the side of the old track, the same method is adopted with this difference, that the rail framing is fitted up in period « A » over the whole length of the section of track which has to be renewed.

In those places where there is not enough room on the banks for building the framing, this is done in the cuttings or above the ditches, along the heaps of filling-in material, or on simple transportable scaffolding.

The progress of the work in periods « B » and « C » is similar, except that after having removed the old track, the first layer of ballast is put down and the new rail frames are slewed into position. This method has the advantage over the first in gaining time in the sense that during the time the line is cut it is possible to place in position a larger number of pairs of rails, even in shorter intervals between the running of trains.

This second method is therefore in use where these intervals are short, especially on single track main lines.

In order to complete this portion dealing with the renewal of the whole superstructure on the track, we are adding a few further remarks relating to the methods of working.

Generally the speed of the trains is reduced over those portions that are being renewed, or when complete relaying is in progress. For instance, on the Belgian State Railways the normal speed is reduced to 12 1/2 miles, on the Danish State Railways from 3 to 15 1/2 miles, on the Northern Railway of Spain and on the Italian State Railways 4 miles, on the Dutch State and on the Czecho-Slovakian State Railways 19 miles, and on the Swiss Federal Railways 28 miles when using the continuous brake, and 19 miles with the hand brake.

In order to ensure the safety of the section on which relaying is taking place, portable signals are used according to the respective regulations of the railway administrations interested, and to warn the workmen of an approaching train whistles or horns are sounded.

It is the custom on the Northern Railway of Spain to fix at a distance of 300 m. (330 yards) before reaching the covering signal a white disc, on which is inscribed in 12-inch black letters the word « Whistle », and on arriving at this spot the driver must give three long whistles.

In addition to this, on the section where relaying of the superstructure is in progress, a portable telephone is used so as to rapidly transmit information concerning the state of the traffic, and thus prevent any avoidable loss of time.

When renewing sleepers, the method of fixing their connections is also of importance. Amongst other questions is that of knowing whether the sleepers should be fitted up at the depot, and sent to their destination already provided with sole plates, chairs, etc., or whether this should be done on the spot; also if the holes for the coach screws should be drilled in the sleepers before creosoting, or at the place where they are to be laid. As regards this, the replies of the various railway administrations are contradictory. Drilling the sleepers beforehand has the inconvenience that while at the depots and during manipulation, the holes are liable to become filled with sand or dirt, from which certain difficulties arise when they are being fixed.

The drilling of sleepers varies according to the kind of rail in use, and those drilled in advance may easily be mistaken for others during handling before arriving at their destination. Loading and unloading sleepers already fitted up necessitates greater precautions being taken in order to avoid damage to their attachments. On the other hand, the work is more quickly accomplished when the sleepers are exactly fitted up by means of machinery.

Most sleepers are only drilled beforehand at one end before creosoting, the other end being left to be drilled on the spot, but where it is possible to fit up the sleepers mechanically at the place where they are treated, this is found to be the better way.

Sleepers capable of being used over again are repaired at once, on the spot,

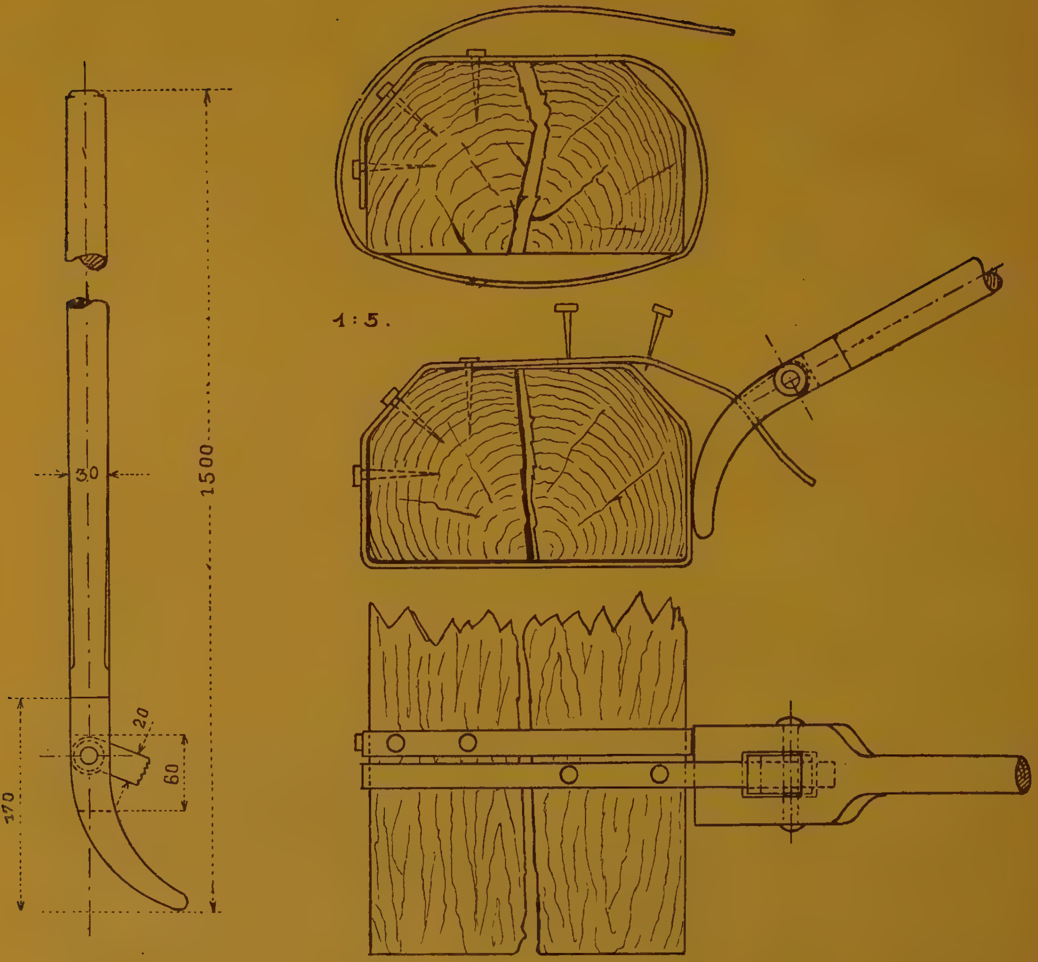

Fig. 14.

after being taken up, or they are sent to the depot, where they are repaired by mechanical means, a method which seems to be most in favour.

Repaired sleepers are put into service again as soon as possible, and those that are split are generally repaired by the railway administrations by means of S-shaped iron sheets.

It is the custom on the Belgian State Railways to strengthen the ends of all new ash sleepers by means of bolts 3/8 to 1/2 inch in diameter. Bands of flat iron are generally used by the Czecho-Slovakian Railways for binding split sleepers.

When the sleepers show signs of longitudinal splitting (especially those of ash), they are banded round by means of a special lever (fig. 14), with a strip of sheet iron 1 1/16 × 3/32 inch, fixed about

3/8 inch from the end of the sleeper by means of five forged nails.

This lever is also used for binding the sleepers when in position, but at the sleeper depots more powerful apparatus is in use, consisting of presses, by means of which the binding is more tightly done.

One of the operations independent of the work which occurs frequently, and which should be mentioned, is the continued renewal of the ballast. As far as it has been possible to come to any conclusions from the particulars sent in, this operation is dealt with by different methods, which in principle depend chiefly on the interval allowed between the running of trains, and we will proceed to describe some of them which differ essentially from one another.

1. — The procedure adopted by the Italian State Railways is as follows :

First of all the top layer of ballast is removed for a length of about 660 feet, then the ballast between the sleepers, and finally the bedding under the sleepers. By this operation the level of the track is lowered progressively, until the sleepers lie directly on the foundation.

The difference of level between what remains of the old track and the section under repair is compensated for by two connections in the longitudinal section over a length of not less than 65 feet, the relative incline not being more than 1 in 50. The new ballast deposited beforehand at the side of the track is then thrown into the latter, which rises bit by bit, forming new beds of ballast, until the track reaches its original position, after which the levelling and trimming are adjusted and the ballast put to the correct section.

2. — The work is done in the following way on the Belgian State Railways :

On double track lines the six-foot is cleared, and the new ballast is deposited on it provisionally. This is brought along by special ballast trains, and unloaded so that no encroachment takes place of the official loading gauge.

The ballast, except that under the sleepers, is removed so that each of the latter is supported by its bed. The signal for slowing down is then given to all trains, and the new ballast is placed between the sleepers. Then by means of a pick the old ballast remaining under the sleepers is removed.

In the intervals between trains the level of the track is maintained by means of crowbars or lifting jacks. The new ballast is placed with shovels, and finally rammed with the pick. It is only after the ballast has been completely renewed in this way in a section and the sleepers have been rammed that work is begun at the next section. With single track lines, the ballast is placed on one side while the old ballast is thrown on the opposite bank, otherwise the operation is identical with the preceding one.

By making use of the first method, during which the bedding of the sleepers is built up as the track is being elevated, we get as a result, due to the circulation of the trains, a perfect compression from the bottom of the bed upwards. On the other hand, the beds not being sufficiently thick to distribute the loads uniformly on the foundation, these axle loads may cause distortion of the surface of the latter. By the second method the axle loads act only after the layer of ballast below the sleepers is approximately of its normal thickness, and the pressure on the surface of the foundation is evenly distributed.

In this chapter, as well as in the preceding one of our report, we have endeavoured to briefly describe a few of the various methods in vogue for dealing with certain characteristic work in connection with keeping the superstructure in condition, thanks to the information supplied by the various railway administrations who have been good enough to reply. Wishing to give an idea of the diversity of methods in use, we have not been able in mentioning them to avoid enlarging over certain details, and we fear we may be reproached for this prolixity.

As regards the special methods of doing the work, it cannot be said that this rapid survey gives even an approximate solution to the question with which we are dealing.

This would require a critical appreciation and a strict comparison of the various methods, in order that their economic results might be verified, by comparing work the conditions of which are nearly identical, so that we might come to some useful conclusion.

From this point of view it is regrettable that this report has to be so concise, for on account of the little time allowed, valuable information which should be at hand when a systematic review is attempted has not been received early enough to be included in this report. Once again, therefore, we feel it right to suggest that a critical study of the subject should be made, and a comparison between the methods of doing the work, as well as bringing forward this question again at a future International Railway Congress, in order to find out which methods offer the best results from both the economic and technical points of view.

CHAPTER III.

Measures that should be taken in order to obtain an improvement in the technical and economic results of maintenance work.

At the last Congress held in 1922, the American delegates presented some very interesting reports on question II, touching the principle of « rational management » of the work of maintenance of the superstructure, and certainly other interesting details will be added during the discussion of the question that has been placed on the agenda for the 1925 Session.

Some European administrations appear to be animated with the desire to profit by all the progress realised in this respect in all the working departments of the railways. There seems to be no doubt that some of the methods of organisation in the workshops might be applied to work in connection with the construction and upkeep of the track, if suitably arranged. Though the conditions of work in the shops and on the permanent way are very different, the modern organisation in the former makes it possible to find a few elements that could with advantage be applied to the latter, even in open country. The particulars to hand, however, are not sufficiently concise to enable us to determine to what degree it would be possible to put into practice for track maintenance the scientific principles that have been adopted in the workshops, and what results might be expected. It is evident, however, that some railway administrations are taking interest in this matter.

The study of, as well as the improvement in the methods in vogue exercise a marked influence on results from the point of view of the principles of economy in the work. Also with regard to the upkeep of the superstructure, this economy in working has a fertile ground to operate on, especially in the methodical distribution of maintenance work by applying the system of general relaying or repairing to the superstructure or its adjuncts.

The fundamental conditions for economy in upkeep work are : procedure according to *programme*, establishment of a budget of costs, *organisation* and methods of working, as well as efficient supervision.

Considering the diversity of maintenance work, especially on account of the frequency of unforeseen occurrences, it is hardly possible to constantly keep to all the details in a pre-arranged programme. Nevertheless, as regards important work which has to be systematically dealt with, it is necessary to fix up beforehand a programme determining the total extent of the suggested operations.

It is on the basis of a programme of the work to be done that a budget can be established as regards the cost and valuation, as much as concerns the importance of the labour required as from the point of view of the quantity of material necessary for the replacement of that which is worn or scrapped. As regards work of less importance, it is advisable also to determine as far as possible the extent of the work, so as to be able to calculate beforehand the number of men necessary to follow up and supervise the operations. This programme, once arranged, serves as a base for the budget, which should be prepared with all possible care, especially for big undertakings which are under the control of the higher officials.

In order to establish these budgets of costs, it is necessary to know the expense involved in each of the operations of which the work consists, as their exact costing constitutes an important condition as regards economy.

A close examinaion of the operations relating to the maintenance of the superstructure shows that in the list of this class of work there are certain operations which may be called elementary, and which may crop up independently, or are included in the total of more complex operations.

For instance, the ramming of sleepers is an elementary operation of this kind, which may happen independently in the ordinary course of maintenance work, or else is eventually included in some other more complicated operation such as adjusting the level of the track, etc. It is therefore necessary in the budget of costs relating to the work, either accomplished by the permanent staff or by contract, as well as for supervision, to know the value of these units, both elementary and complex, that can be estimated for.

Elementary units of which the more complex operations are composed should be easy to estimate, and expressed in such a way that their description leaves no room for doubt. A more detailed splitting up of these fundamental units into still simpler elements would not be of great value as far as the ordinary maintenance work is concerned, and this circumstance brings to light the difference between work on the open track and that in the workshops. On the other hand, it is still necessary also to weigh up in addition to the elementary operations those that are more complex, and which crop up independently. In this respect it is necessary that the estimates should include for the requirements of the general budget the costing of the more complicated operations, such as the repairs required for the track as a whole according to various graduations dependent on local conditions, kind of rails, etc. The value of the operations is measured by time, that is to say in hours of work, brought down to a unit of measurement, determined and fixed beforehand.

Such a list of elementary and complex operations is shown in appendix A, taken from the list of units of work used for the above mentioned purpose on the Czecho-Slovakian State Railways.

The amount of work done at each operation evidently varies considerably according as the gangs are made up of experienced or inexperienced workmen engaged on the different classes of work, the kind of tools used, and especially as regards the methods adopted for doing the work.

For a normal amount a comparison may be made with a normal gang expert in this class of work, using the most appropriate tools, and according to the best methods. Though both the economic and technical interests necessitate a constant improvement in the methods of working, it is always advisable to standardise or co-ordinate the best known methods, and to see that they are applied in maintenance work, so as to avoid the use of less perfect ones. Such a co-ordination of working methods should not, however, put a brake on the inventive talents and efforts put forward by the supervisory officials to improve the manner in which the work is done, but should rather be an assistance to the practical regulations laid down for doing the work, and the door should always be left open for more perfect methods which are not always those known as « standard ».

It is evident that for the work to be done economically it is important to decide on the best means which give with the minimum amount of labour the best results from the technical point of view.

It is only by forming a base on fixed methods that the value of each of the operations can be arrived at, either in the workshops or better still on sections of line that are in the hands of specialists for testing purposes.

Tabulating such statistics, however, the usefulness of which is recognised by numerous railway administrations, necessitates careful watching over a long period, but the resulting economic and technical advantages largely repay the necessary labour and expense involved in establishing and administrating the statistics relating to the work.

The Czecho-Slovakian State Railways arrange their sequence of operations relating to maintenance of the track according to the table shown in appendix B, based on observation of the operations in current working in the midst of most adverse conditions, standardising for current operations and frequently repeating the normal methods, as well as the new results according to the various sections of the line where conditions are similar. These methods of working should be described as briefly as possible, but in the clearest possible way, and where a description of the operation itself is not given, the amount of labour is stated, which in certain odd cases, such as hurrying on the work, may be added to the existing staff.

This document is also used in supervising the work, the distribution of which should be arranged so as to be under control in as large a degree as possible.

In order that the work done by the gangs shall be properly supervised, forms relating to it have to be filled in by the gangers themselves. A sample of this form, as used on the Belgian State Railways, is shown in appendix C, and the way it is filled up in appendix D. This form is arranged so as to help in preparing statistics, as well as to give information relating to the different results appertaining to the work.

In order to control some of the more important operations as regards the superstructure, special diagrams and charts are also in use on many railways. The graphical representations of maintenance work are very valuable documents as regards the programme to be arranged and the supervision necessary. Generally speaking these charts have for their objects :

1° To represent the programme of important operations which should be done to the track during the current year, such as repairs to the superstructure or to the permanent way, renewing — according to requirements, — the fundamental elements of the latter, general relaying, as well as repairs required after inspection;

2° To indicate the general progress of the work, especially in relation to the programme issued for the purpose;

3° To show visually by means of a properly arranged table the most effective means of utilisation of labour in relation to the extent of the work carried out, as much as regards its linear progress as to that which relates to the cost of wages;

4° To draw attention to those portions of the track which require for their revision heavy expense, or to weak sections which require frequent repairs. After thorough inspection in such cases, the supervisors should discover the causes of these defects, and take proper measures to prevent their recurrence;

5° To compare the results of work done by different gangs;

6° By the use of a graphical representation it is possible in time to arrive at the average number of yearly working hours required for each kind of operation appertaining to the upkeep of the track, and by this means settle the budget of costs relating to the wages of the workmen.

These charts therefore resolve themselves into documents used to organise the maintenance work of the track according to a programme, allowing the possibility of controlling the work, and so contributing means to economically make use of the labour element. These charts are constructed from the report or checking book, mentioned above, filled in by the head ganger.

The form on which these charts are drawn up on the Belgian Railways is shewn in appendix *E*, and they are filled in by the Chief of the Section from the information supplied to him from the record books of each of the head gangers. These charts are made out at the end of every fortnight and to a scale of 2 mm. 5 per 100 m. (7/64 inch per 110 yards) longitudinally and 1 mm. (3/64 inch) for 10 hours of work vertically.

The lines are shewn in blue pencil for ordinary upkeep work and in red or black pencil for other work which is exceptional. The work done each month is shewn on the charts by a line determined by two arrows and across which the name of the month in question is shown. The charts for successive years are kept on the Section, and by comparing them it can be shown to what extent the latter is kept in proper repair and also indicate the points in the Section which during the general revision have necessitated exceptional attention. (In such cases the reasons have to be found with a view to their being remedied later on. The charts will also show those spots which apart from the general relaying require special attention as far as repairs are concerned. In these cases also the cause should be found and remedied.)

These diagrams also allow the work of each gang to be followed and their efficiency compared up to a certain point.

The Chief of the Section hangs up in his Office the diagrams relating to the current year so that they can be easily consulted, and the technical inspector can with a single glance form an opinion of the regular procedure of the work. The comparison of the progress made also tends to stimulate the work of the staff.

The diagram used for maintenance work on the Czecho-Slovakian State Railways is shown in Appendix F, and is kept by the head of the District. The method of using it is shown in a general way on the printed sample, repairs to the track only having to be added. The strengthening of the superstructure, general relaying and repairs resulting from inspection are shown in different colours : blue, green, yellow and red.

In the preceding chapter a short account was given of the application of some of the principles relating to the methodical organisation of work done in the workshops and that carried out outside on the open track. According to the method work is organised in the workshops so should it be done on the track so that the actual details of all the operations required may be known and their efficiency and completeness checked. By this means any unnecessary time spent will be ascertained and the supervision rendered easier and more effective, which will naturally increase considerably the amount of work done.

There are other methods that might be adopted with a view to giving better working results. For instance, greater efficiency may be obtained by having the repairs to the superstructure done at piece work prices or letting it out to contractors on pre-arranged conditions.

Bearing in mind the variability and special nature of maintenance work in which the safety of the traffic and the responsibility in maintaining this safety, has to be considered as well as the different conditions of work and wages existing in each country, it is not possible to give a categorical answer to the question of which method is really the most effective or the most advantageous from the technical and economical points of view, as regards work done by the day work system, by piece work, or by contractors.

The Belgium State Railways are of opinion that the whole of the work relating to the superstructure may be let out on contract.

The Italian State Railways have obtained the best results by letting the work out at the same time keeping an uninterrupted and close supervision to see that the contractor employs experienced workmen. This administration distributes the great seasonal operations to contractors who have proved to be worthy of confidence and on occasion to the co-operative societies which exist there.

The contract is issued in such a way that the administration can, during the course of the work, allow the contractor to do other work which is considered necessary or leave that out which may be found to be unnecessary up to the fifth of the value of the contract without the contractor being able to claim any special compensation. Additional work which is considered necessary is paid for at the price laid down in the contract and if this is not mentioned in the latter it is arranged separately. Material is not as a rule included in the contract, but sometimes gravel is supplied to replace the old ballast.

The contractor is expected to furnish

the necessary tools and mechanical appliances.

Sometimes the Railway Administrations in special cases loan tools to small contractors, who however are expected to pay for their use, loss, or any damage done to them. Transport of material from the nearest railway station to where the repairs are to be done is at the contractors expense. The latter is also responsible for the safety of his men whilst the administration supervises the work done according to the terms of the contract. This control and supervision are in the hands of the railway officials appointed for the purpose who take note of the progress of the work and are empowered to stop it if it is not being properly done. The administration also passes the work as soon as it is finished.

The Swiss Federal Railways propose to repair the superstructure at piece work prices, either by contractors or by gangs of experienced workmen chosen from those who have been pensioned off but are still capable of working.

From the particulars received it would seem that outside the railways mentioned above no other administration employ contractors for doing their work.

On the other hand railway companies frequently allow their own workmen to do work which it is easy to estimate and supervise at piece work prices.

Generally speaking we may say that amongst the objections raised against allowing contractors to do the work are the following : uncertainty as to the nature of the operation, expensive supervision, occasional inferior quality of the work, uncertainty as to the conditions on which the contract is based especially as regards the pricing of each separate operation, the more or less danger, or at least probability, of accidents or injuries occurring to strange workmen by the passing trains, the complications in calculating the value of the operations, especially as is frequently the case, other work, the necessity for which had not been foreseen, crops up unexpectedly.

On the other hand an advantage lies in the fact that the work is more rapidly done, the contractor having greater liberty in the choice of labour can in consequence get more out of it.

Some of the drawbacks however mentioned above may in favourable circumstances be turned to good account especially as regards the quality of the work. An experienced contractor that can be relied upon, who is equipped with suitable tools and mechanical contrivances, and has an experienced staff of foremen and workmen, can generally obtain not only quicker results but also a better class of work than that usually done by the permanent staff.

Maintenance work that is well organized especially as regards the utilization of correct methods in doing it as mentioned above, and also basing it on detailed statistics relating to costs and estimating the latter as closeley as possible, results in doing away with many of the objections to letting out to contract repairs to the superstructure. If there were no particular difficulties to surmount, such as the question of giving a guarantee by the Railway Administrations for any accident happening to strange workmen, and generally that relating to insurance against accidents according to the legal requirements of each country, there is still the grave objection which cannot be minimized that letting out work to contractors necessitates a very active and consequently costly supervision, beyond the absolute good faith one may have in the contractor.

In order to obtain favourable results

it is also necessary to arrange, in agreement with the contractor, as full an estimate and price list as possible, and containing, above all, the particulars relative to the payment for work done, as well as arrangements to cover reductions or increases in wages, guarantee of the quality of work for a certain period after completion, conditions of acceptance, regulations for safety, arrangements relating to the supervision and control; in addition there is the question of penalties, arrangements in case the contract should be broken, unloading and loading material and tools, technical regulations relating to the method of working, etc.

When taking into account the advantage or otherwise of doing the work either by permanent staff or by contract, particular importance must be attached to the conditions relating to work in each country, as well as the question of wages and the insufficiency or super-abundance of labour and its quality.

The importance of the work that may be entrusted to a contractor in the most favourable cases, appears to be governed theoretically by the number of workmen on the permanent staff, that is to say those engaged in work which will occupy them without interruption all the year round and should not be interfered with even for the sake of the railway company being independent of contractors.

It follows from this that the work let out to contractors can only be that depending on the season; for instance, relaying the superstructure and the track and the general renewal of ballast, sleepers, rails, continuous revisions, etc.

With work of greater importance it is possible for the contractor to make more complete use of mechanical contrivances which as a rule cannot be done when the work is in the hands of the permanent staff.

With the latter method, especially when dealing with railway work of lesser importance, mechanical contrivances, which are very expensive (such as the « Scheuchzer Weeding Machine »), could not be used with economy. By allowing the contractor to do work of greater importance to the superstructure the high costs due to supervision and inspection of work are compensated for by the economical advantages gained.

An increase in work done may be obtained by the bonus system, based on giving bonuses for better results. From the particulars furnished by the Railway Administrations it appears that some of these give piece work prices for certain definite work, whilst others, acknowledging the impetus obtained by giving bonuses in order to obtain a greater output, propose to introduce the system.

The present system of allocating bonuses does not appear to be established on any rational basis.

The Belgian State Railways give higher wages for work that must be done at greater speed such as may happen for instance in case of railway accidents, or in case where danger might arise if there were any delay in carrying out the work.

The Dutch State Railways give special remuneration for increased speed of working, such as when the track is renewed, it being understood that for about a week the work is done in the ordinary way, when the average output is adhered to, after which a contract price for the remainder is arranged. By this means an increase in efficiency in labour of about 25 % has been obtained.

The Italian State Railways, which before the world war allowed bonuses, stopped them later, but intend reintroducing them based on principles relating to the scientific management of the work.

The Swiss Federal Railways are giving

the bonus system a trial in such a way that according to the experience acquired, a settled maximum amount of work has been determined for any increase on which a bonus is allowed.

A bonus system presupposes a precise fixing of the fundamental amount of work that should be done compared with that which is actually obtained. A sure base on which to establish this system consists in keeping exact statistics relating to the work mentioned above, and which include the normal amount of time required for each of the operations, elementary or complex.

An intelligent appreciation of the work that should be done and the allocation of suitable bonuses should take into account involuntary losses of time, due for instance to the traffic.

There is reason to consider as « normal work achieved » the net amount turned out, such as that given by an average gang on the main line, in doing the work during the suspension of traffic or during the time between trains. For each operation consideration should be given to the amount of time that should be subtracted from the effective working period, for involuntary losses caused by the dependence of the work on the traffic (delays to service trains, interruptions in the work due to trains, etc.).

These losses of time are greater on lines with the largest amount of traffic, and can be estimated in bulk as a percentage in relation to the total time taken for each line separately, or by comparing the actual particulars that are noted in the head ganger's report book. The bonus system, though offering certain economic advantages, necessitates, however, that the quality of work performed should be very closely supervised.

Obtaining the greatest amount of work in a certain time is favoured by the mechanical contrivances and installations partly taking the place of manual labour.

Above all it is necessary, in order to economise time, to have rapid and cheap means of transport, both for men and material, to the spot where the work is being done.

For the transport of smaller quantities of material, the Belgian State Railways use small cars called « diplorys ».

For trial purposes the Czecho-Slovakian State Railways are using, for the transport of men and heavy and light material, a system of motor car arranged with a two cylinder four stroke engine, the cylinders being opposite each other, and giving 14 gross H. P. at 1 300 to 1 400 revolutions. The diameter of cylinders is 90 mm. (3 9/16 inches) and stroke 120 mm. (4 3/4 inches). This engine is placed under the floor of the car, the lowest portion being at least 150 mm. (5 7/8 inches) above the rail level.

The area of the surface which can be loaded is about 27.98 square feet, and as it stands 2 ft. 5/8 in. above the rails, it can be worked without trouble.

The transmission has two speeds, both for forward and back, and the maximum speed is about 19 miles per hour.

The drive is transmitted to the axle through a chain, and the vehicle is provided with mechanism to raise and turn it round its vertical axis. When empty it can be easily lifted off the track in about one minute. Its weight is about 2 650 lb. and the car is useful to distribute material along the line during repairs to the superstructure, or general relaying of greater importance.

Its power is such that it can be coupled up to an ordinary wagon loaded with 13 rails 41 feet long, weighing 112 cwts., and containing 12 workmen of a total weight of 18 cwts. making in all 140 cwts., and is able to ascend gradients of 1 in 70 at a speed of about 19 miles per hour. It can be stopped in a distance of 100 to 165 feet. The results obtained up to the present have been reported as quite satisfactory.

The Swiss Federal Railways also use motor lorries for the transport of workmen and light track material. The motor is placed in the centre of the floor of the lorry, leaving space on each side for the men, and an ordinary small wagon or a « diplory » can be coupled to it for the transport of heavy material. The results so far are said to be encouraging.

It is evidently better for the transport of large quantities of heavy material, to use special service trains, especially on those lines where traffic is heavy.

By this means, and the use of special wagons for the distribution of material, especially ballast on the track, as well as arrangements for unloading material on the spot, sensibly increases the amount of work done in the time.

The use of mechanical devices has not up to now proved a serious competitor to manual labour.

Numerous Railway Administrations are considering the question of substituting mechanical appliances for manual labour, but judging from the particulars received, not one of them is yet able to give a definite answer as regards the general advantages of mechanical apparatus.

The Italian State Railways state, however, that they use a complete system of mechanical devices known as the « Collet Workshop ».

This arrangement is known to offer great advantages for repairs to the superstructure, to the track, and for general relaying of a wider scope. When it is applied, however, to shorter sections, or to current upkeep work, there is not sufficient to keep all the apparatus employed, and in such cases the Railway only uses the mechanical rammers.

The German State Railways use pneumatic rammers to a large extent. These are composed of an air pump worked by a 4 H. P. benzine motor, and having two hammers joined to the air pump by short pipes. This pump is fixed on a frame 6 ft. 11 1/2 in. long and 1 ft. 3 in. wide, which when the work is in progress is placed outside the track on the ends of the sleepers, and may by drawn by a chain along the track from sleeper to sleeper, according to requirements, and so that it does not interfere with the running of trains. Its height is 7 3/4 inches, and when required small wheels can be fitted to enable it to run on the rails, resting on the track in a position perpendicular to the latter. The hammers give 1 400 blows per minute, and the weight of the apparatus is 232 to 242 lb., and that of the two hammers is 77 to 101 lb. The consumption of benzine varies from 10 1/4 to 24 1/2 pints, and oil from 1 1/4 to 3 1/2 pints, for eight hours' work.

The mechanical rammer gives a large number of gentle vibratory blows insufficient to break the ballast, but on the other hand shakes it up so that the bed is uniformly compressed. The bed of ballast produced mechanically below the sleepers is more perfect and consequently more durable, so that mechanical ramming need not be so often repeated as that done by hand.

The wear of the ballast and sleepers is also found to be less when rammed mechanically, and the advance of the work is more rapid, so that for this reason delay to traffic during important work is much reduced.

In spite of these advantages, the general use of mechanical ramming has not become popular as far as we can judge from the communications received, due probably to the, as yet, imperfect construction of these tools and their high price. Though the technical literature on the subject gives the economic value of mechanical ramming at 40 % above manual labour, this statement is not readily accepted by numerous administrations. The Swiss Federal Railways for instance have obtained at the most from mechanical ramming an advantage of 20 %, and according to the Italian State Railways the economy realised cannot be said to be of much importance.

Amongst the other mechanical devices that give good results may be mentioned drills for sleepers and for screwing up the coach screw. The tools for replacing the rails in their normal position after creeping, as well as the lifting jacks which automatically hold the track up in position, are indispensable for all important track work.

The Swiss Federal Railways use the Scheuchzer weeding apparatus with good results.

For important continuous work, such as repairs to the superstructure, etc., it is advisable to use the complete outfit of mechanical apparatus, including adzing machines.

In general relaying or when a large number of sleepers have to be renewed mechanical ramming gives good technical and economical results. As a rule in order to obtain a favourable effect from mechanical contrivances it is necessary that they should be efficient, relatively cheap, and easy to repair (as far as possible the various parts being made to gauge with a view to the easy replacement of those that are worn).

Technical and economical results in getting the work done are also influenced by many other methods made use of by some Railway Administrations, such for instance as that of periodically gauging the actual state of the track by means of suitable apparatus (the Swiss Federal Railways use the Dorpmüller apparatus).

Setting out the run of the track by means of fixed marks is to be recommended for main lines especially those of a sinuous and complicated section. The fact of providing the track with fixed gauge marks makes its upkeep easier, by reducing the expense of staking out the run of it, a necessary operation when important repairs are in progress.

This marking out of the run is chiefly used on the German Railways, and was introduced later on the Czecho-Slovakian Railways when repairing their main lines.

Finally, amongst the other measures having for their object increased efficiency in working should be mentioned the instruction of and training the staff and especially that given to the foremen by means of special classes. The workmen also receive instruction by means of lectures and instruction sheets and pamphlets.

SUMMARY.

The upkeep of the superstructure should be such that after allowing for occasional defects it may be safe for traffic. The method of keeping it in repair should generally speaking ensure its good condition from the technical point of view, and from the economical point of view prevent as far as possible premature renewal of material, as well as working losses.

This method necessitates the superstructure to be examined methodically according to plan at fixed periods the length of which depends on circumstances and the repairs should be proceeded with in such a way that the control of the work should be as complete as possible and amount done the largest amount possible.

To ensure this the work should be distributed in such a way that it falls in the most favourable season in the year for its particular nature; for instance :

1. — Continuous revisions, renewals the rest of the time being taken up with ordinary repairs.

2. — It is advisable to arrange a preconcerted plan to systematically study and organize special methods for carrying out each of the operations, taking for basis well thought out observations and exact tests founded on the best experience, at the same time taking into consideration the value of mechanical devices as regards their efficiency and capacity.

3. — It is also advisable to systematically examine the methods and organization of the work attached to continued renewal of the superstructure, the track, the sleepers and the ballast, both from a general and a detailed point of view so as to improve the technical methods of working in order to secure the greatest economy in labour such as eliminating unnecessary losses in time,etc.).

4. — It seems possible to adopt the principles of rational management in work connected with the outside maintenance of the superstructure by making use of the known methods in workshop practice and adapting them to the particular requirements of track work. This is a question however which requires careful consideration.

5. — From the technical and economical points of view the letting out to contract of the seasonal superstructure work, such as renewals of the latter, the track ballast, sleepers, etc., to a contractor (or else at fixed price) is generally admissible on the condition that the estimate stipulates exactly the rights and duties of both contracting parties, that an efficient supervision is arranged and that the contractor is thoroughly worthy of the confidence of the company and has a thoroughly experienced and competent staff.

On the other hand it is not advisable to have recourse to a contractor for ordinary maintenance work, which should be done by the normal gangs of permanent workmen who are occupied all the year round with their fixed duties.

6. — The payment of bonuses for more work turned out is an economical measure presenting advantages to both employers and employed, but only on condition that an effective and close supervision over the quantity and quality of the work is arranged for and that the bonuses are calculated carefully and correctly by comparison with the normal amount.

7. — The use of mechanical devices is an advantage for the more important superstructure work and offers both economical and technical advantages as long as the tools used are appropriate. In order however that the economical results may be satisfactory, the work should be so organized that perfect accord exists between the work done by hand and that done by machinery.

APPENDICES.

Appendix A.

List of units of work.

DESCRIPTION OF UNITS OF WORK.	Unit of measure
I. — Preliminary work	
1. Complete inspection of the track in view of general relaying . .	m.
2. Staking out, including gauging	m.
II. — Track material. Manipulation and utilisation	
A. — RAILS.	
1. Unloading rails from wagons by hand	t.
a) on the track, including placing them on the banking along the track	t.
b) including placing them in piles along the track	
2. Unloading rails from lorries and placing them along the track . .	t.
3. Loading rails on wagons.	t.
a) distributed along the track	
b) from the piles alongside the track	
4 Loading the rails on tip wagons	t.
a) distributed along the track.	
b) from the piles alongside the track	
5. Transport of rails on lorries without loading or unloading of material, with gradients up to 1 in 200 for 1 km.	t.
6. Loading, transport on tip wagons, and unloading an insulated rail .	t.
a) up to 1 km (0.6 mile);	
b) from 1 to 2 km. (0.6 to 1.2 miles);	
c) from 2 to 4 km. (1.2 to 2.4 miles);	
d) beyond 4 km. (2.4 miles)	
7. Cutting the rails with a saw, including the preparation for this process	1 cut.
a) up to weight of 26 kgr. (52.4 lb.);	
b) above 26 kgr. to 36 kgr. (52.4 lb. to 72.5 lb.);	
c) above 36 kgr. (72.5 lb.).	

DESCRIPTION OF UNITS OF WORK.	Unit of measure.
8. Cutting the rails by means of a hammer and chisel, trimming up and filing the section	1 cut.
a) up to 26 kgr. (52.4 lb.);	
b) above 26 kgr. to 36 kgr. (52.4 lb. to 72.5 lb.);	
c) above 36 kgr (72 5 lb.).	
9. Hand drilling the rails, including the necessary preparation . . .	...
10. Continuous laying down of rails, using those already distributed at the spot.	m.
11. Loading the rails distributed along the track on to lorries and transporting to the depot, unloading and piling up to a distance of 11 yards from the track for a length of transport. . . .	t.
a) up to 1 km. (0.6 mile);	
b) from 1 to 2 km. (0.6 to 1.2 miles);	
c) from 2 to 4 km. (1.2 to 2.4 miles);	
d) above 4 km., up a gradient of 1 in 200.	
For gradients of 1 in 200 to 1 in 100, increase of ... °/₀.	
— — of more than 1 in 100, increase of ... °/₀.	
12. Rounding the rail heads with a rounding machine	m.
13. Turning a rail round in place	m.
B. — SLEEPERS.	
1. Unloading wooden sleepers	100 sleepers.
a) on the running track (From the service train). . . . 1st unloading only. 2nd unloading and distribution on the bank at the spot. 3rd unloading and piling in heaps of 50 sleepers.	
b) in the yards. 1st unloading only. 2nd unloading and piling in heaps at distances up to 10 m. (33 feet).	
Bonus for unloading sleepers recently treated (damp) ... °/₀.	
Bonus for discharging fitted sleepers ... °/₀.	
2. Unloading wooden sleepers from lorries, including their distribution along the track	100 sleepers.
3. Loading wooden sleepers into trucks	100 sleepers.
a) distributed along the track	
b) at depots alongside the track.	
4. Loading sleepers on tip wagons.	100 sleepers.

Description of units of work.	Unit of measure.
5. Transport of wooden sleepers on tip wagons (without loading or unloading of material) up to a distance of 1 km. and gradient of 1 in 200.	100 sleepers.
6. Loading on tip wagons sleepers distributed along the track, including their transport to the depot, unloading, and piling up to a distance of 10 m. (33 feet) from the track, on a maximum gradient of 1 in 200. *a)* up to 1 km.; *b)* 1 to 2 km.; *c)* 2 to 4 km.; *d)* above 4 km. For a gradient of 1 in 200 to 1 in 100, bonus of ... °/o. — — above 1 in 100, bonus of ... °/o.	100 sleepers.
7. Adzing sleepers (by hand) including tarring . . . . *a)* soft . . . . . 1st for sole plates; 2nd for plates; 3rd for holding down plates. *b)* hard . . . . 1st for sole plates; 2nd for plates; 3rd for holding down plates.	1 surface.
8. Adzing sleepers in the track with a view to rectifying the slope of the rails with all their accessories (taking down and putting back).	1 surface.
9. Hand drilled holes in sleepers. . . . . *a)* soft. Drilling through; *b)* hard . . . . 1st right through. 2nd to two-thirds of the depth.	1 hole.
10. Mechanical drilling (piercing system) . . . . *a)* soft. Drilling through; *b)* hard . . . . 1st right through; 2nd to two thirds of the depth.	1 hole.
11. Binding the sleepers at one end with iron strap by means of a simple lever. *a)* at the sleeper depot on prepared support; *b)* in the track itself, including moving and replacing the ballast; *c)* at the depot, similar to *a)*, but with the press.	1 end.

Description of units of work.	Unit of measure.
12. Fastening down through the holes drilled in the sleepers, including tarring of the cramps *a*) in sleepers of hard wood; *b*) in sleepers of soft wood.	Per piece.
13. Coach screwing (by hand) in holes drilled in the sleepers, including tarring *a*) hard; *b*) soft.	Per piece.
14. Taking cramps from sleepers *a*) hard; *b*) soft.	Per piece.
15. Taking coach screws from sleepers by hand *a*) hard; *b*) soft.	Per piece.
16. Replacing sleepers by unfitted ones, including double ramming *a*) on main line; *b*) at stations. Extra pay for tunnels, metal bridges, and level crossings.	Per piece
17. Replacing sleepers as in No. 16, but with sleepers already fitted up. *a*) on main line; *b*) at stations. Extra pay as in No. 16.	Per piece.
18. Adjustment of displaced sleepers in run of track, including double ramming *a*) on main line; *b*) at stations. Extra pay as in No. 16.	Per piece.
19. Displacing sleepers perpendicularly to the run of the track, including binding, and adzing their carrying surfaces. *a*) on main line; *b*) at stations. Extra pay as in No. 16.	1 sleeper.

DESCRIPTION OF UNITS OF WORK.	Unit of measure.
C. — MINOR MATERIAL.	
1. Unloading minor material from wagons and depositing up to a distance of 10 m. (33 feet) from the track . . . . *a*) in boxes; *b*) in bulk.	100 kgr.
2. Unloading minor material from lorries and depositing up to a distance of 10 m. from the track . . . . *a*) in boxes; *b*) in bulk.	100 kgr.
3. Loading up minor material on wagons from distant depot up to 10 m. from the track. . . . . *a*) in boxes; *b*) in bulk.	100 kgr.
4. Loading minor material on lorries from distant depot up to 10 m. from the track . . . . *a*) in boxes; *b*) in bulk.	100 kgr.
5. Fixing plates or chairs on new sleepers at depot . . . . *a*) holes to drill . . { 1st holding plate, system ... 2nd ordinary plate, system ... *b*) holes drilled beforehand . . . { 1st holding plate, system ... 2nd ordinary plate, system ...	Per piece.
6. Replacing fishplates . . . . *a*) with four bolts . { 1st replacing one fishplate. 2nd — pair of fishplates. *b*) with six bolts. . { 1st — one fishplate. 2nd — pair of fishplates.	Per piece.
7. Replacing bolts, including greasing.	Per piece.
8. Replacing defective plates, including adzing the carrying surface of sleepers and tarring, and where necessary binding and drilling of new holes . . . . *a*) ordinary; *b*) holding plates.	Per piece.

DESCRIPTION OF UNITS OF WORK.	Unit of measure.
D. — BALLAST.	
1. Unloading stone ballast from wagons	m^3
a) on the track. { 1st on one side ; 2nd on both sides.	
b) at stations. . { 1st unloading only ; 2nd unloading and heaping (outside the gauge limit).	
2. Unloading stone ballast from tip wagons	m^3
a) on the track. { 1st on one side ; 2nd on both sides.	
b) at stations. . { 1st unloading only ; 2nd unloading and heaping (outside the gauge limits).	
3. Unloading gravel, sand and clay from wagons	m^3
a) on the track (unloading only) . . . { 1st on one side ; 2nd on both sides.	
b) at stations. . { 1st unloading on one side ; 2nd unloading and heaping.	
4. Unloading, gravel, sand or clay from wagons	m^3
a) on the track (unloading only) . . . { 1st on one side ; 2nd on both sides.	
b) at stations. . { 1st unloading on one side ; 2nd unloading and heaping.	
5. Loading ballast in wagons, the material being at the sleeper level.	m^3
a) ballast of broken stone ; *b*) gravel ; *c*) slag.	
6. Loading ballast on tip wagons	m^3
a) ballast of broken stone ; *b*) gravel ; *c*) slag.	

DESCRIPTION OF UNITS OF WORK	Unit of measure.
7. Loading ballast on tip wagons from depot by the side of the track, including transport and unloading for maximum gradient up to 1 in 200	m^3
a) up to 1 km.;	
b) from 1 to 2 km.;	
c) from 2 to 4 km.;	
d) more than 4 km.	
For gradients of 1 in 200 to 1 in 100, extra pay ... °/₀.	
— — above 1 in 100, extra pay ... °/₀.	
8. Transport on tip wagons of ballast, quarry stone, sand, slag, broken clay, to a distance of 1 km. (without loading or unloading).	m^3
9. Sieving ballast with the fork	m.
a) to the bottom edge of the sleeper;	
b) to 15 cm. (6 inches) below bottom edge of sleeper;	
c). to 20 cm. (7 7/8 inches) below bottom edge of sleeper.	
10. Sieving the ballast on fixed sieves	m.
a) to the bottom edge of the sleeper;	
b) to 15 cm. below bottom edge of sleeper;	
c) to 20 cm. below bottom edge of sleeper.	
11. Ballast deposited on bank thrown on track.	m^3
12. Complete renewal of ballast, using old material, including ramming sleepers	m.
a) 15 cm. below sleepers	m
b) thickness of ballast under sleepers 20 cm.	
13. Final trimming of ballast	m.
14. Taking away clay residue after sieving, including loading and unloading	
15. Replacing ballast at junctions	m^3
a) on wooden sleepers;	
b) on iron sleepers.	
III. — **Branches.**	
1. Unloading constituent elements from wagons	t.
2. Unloading constituent elements from tip wagons	t.
3. Loading constituent elements into wagons	t.

Description of units of work.	Unit of measure.
4. Loading constituent elements into tip wagons	t.
5. Fixing support intended for fitting up a simple junction.	Per piece.
a) extra pay for double branch ... °/₀;	
b) extra pay for English type ... °/₀;	
c) extra pay for crossover branch ... °/₀.	
6. Fixing a simple branch	Per piece.
a) with wooden sleepers;	
b) with iron sleepers.	
7. Complete replacement of a simple junction, the new junction being put together on the side without unfastening or sorting the recovered material	Per piece.
a) extra pay for double branch ... °/₀;	
b) — — English branch ... °/₀;	
c) — — crossover branch ... °/₀.	
8. Replacing the point.	Per piece.
9. Replacing the check rail	Per piece.
10. Replacing the chair for the point heel	Per piece.
11. Unloading branch sleepers from wagons:	
a) wooden sleepers	m^3
b) iron sleepers	t.
12. Unloading branch sleepers from tip wagons:	
a) wooden sleepers	m^3
b) iron sleepers	t.
13. Loading branch sleepers into wagons :	
a) wooden sleepers	m^3
b) iron sleepers	t.
14. Loading branch sleepers into tip wagons :	
a) wooden sleepers	m^3
b) iron sleepers	t.
15 Cartage of wooden sleepers per km. (without loading or unloading the material)	m^3
16. Ramming branch sleepers in ordinary upkeep :	
a) in wood	Per sleeper.
b) in iron	Per sleeper.

DESCRIPTION OF UNITS OF WORKS.	Unit of measure.
17. Replacing branch sleepers and double ramming.	
a) in wood	Per piece.
b) in iron	Per piece.
18. Replacing the frog.	
a) in wood	Per piece.
b) in iron	Per piece.
19. Reversing the frog	Per piece.
20. Replacing point lever	Per piece.
21. Replacing point bolts	Per piece.
22. Replacing crossover check rail	Per piece.
23. Replacing cross rods.	Per piece.
IV. — **Upkeep of the track.**	
1. Ramming sleepers	Per piece.
a) on the old bed;	
b) on the new bed.	
2. Adjustment of square joints (adjustment of creeping), including that of the sleepers near the joints	Per joint.
3. Arrangement against slipping of the rails	Per set
a) fitting up;	
b) taking down.	
4. Adjustment of the gauge of the track and the slope of the rails by means of renailing	Per sleeper.
5. Straightening the track.	1 m.
a) with average slewing of 10 cm. (3 $^{15}/_{16}$ inches);	
b) with average replacement of 10 to 20 cm. (3 $^{15}/_{16}$ to 7 $^{7}/_{8}$ in.);	
c) with a replacement of more than 20 cm. (7 $^{7}/_{8}$ inches).	
6. Adjustment of the track level	1 m.
a) raising up to 10 cm. (3 $^{15}/_{16}$ inches);	
b) raising above 10 cm.	
7. Raising and ramming sleepers near joints that have sunk	Per joint.
8. Restoring the allowance for expansion.	1 m.
9. Fitting up the joints of insulated rails and ramming under the joints.	Per joint.

DESCRIPTION OF UNITS OF WORK.	Unit of measure.
V. — Reconstruction of the superstructure.	
1. Staking and marking out the run of the track.	m.
2. Forming the bed for the deposit of ballast	m.
3. Transport, loading unloading and stacking of rails	t.
4. — — — — sleepers	100 sleepers.
5. — — — — minor material . . .	100 kgr
6. Transport, loading, unloading and piling of ballast	m³
7. — — — — material taken from the track . . .	...
8. Rounding the rails (cintrage)	m.
9. Fixing plates, chairs, etc., on sleepers	per sleeper.
10. Work preparatory to fixing the track at the side	m.
11. Fixing up the framework of the new track at the side	m.
12. Reconstruction of the track properly so called, including slewing over the framework of the new track from the side, raising and trimming up the new track so that trains may pass over at normal speed	m.
13. Reconstruction of the track properly so called, including fixing the new track in its final position, raising and trimming the new track so that trains may pass over at normal speed	m.
14. Adjustment of the level and complementary trimming of the track in the interval allowed before the work is definitely handed over . .	m.
15. Sorting out recovered material	t., kgr., m³.
16. Various supplementary work	...
VI. — Various items.	
1. Spacing out the sleepers and marking their exact positions with colour on the rails	m.
2. Increasing the number of sleepers	m.
a) one sleeper { 1st rails 9 m. (29 ft. 6 3/8 in.) long; 2nd rails 12 m. 50 (41 feet) long; 3rd rails 15 m. (49 ft. 2 1/2 in.) long.	
b) two sleepers { 1st rails 9 m. long; 2nd rails 12 m. 50 long; 3rd rails 15 m. long.	
c) three sleepers { 1st rails 9 m. long; 2nd rails 12 m. 50 long; 3rd rails 15 m. long.	

Description of units of work.	Unit of measure.
3. Making ballast by hand. . . . . *a*) hard ballast; *b*) soft ballast.	m³
4. Getting and loading up ballast at quarry	m³.
5. Joining up of frozen parts by wedging . . . . *a*) introduction and fixing of wedges { up to 10 mm. (3/8 inch); above 10 mm.; *b*) extraction of wedges and re-arranging track.	1 m.
6. Weeding the ballast. *a*) from ballast of broken stone.; *b*) from gravel ballast.	
7 Cleaning the ditches along the track after inspection on the spot.	m

Remarks :

The procedure of tabulating the work mentioned above in the special pocket books should be made in such a way that the examination of how the work is progressing can be easily made. With this object, and so as to obtain a certain uniformity in the reports, a list of instructions has been provided for the use of the chief gangers relating to the description of the work done.

The following is an extract from these instructions :

VII. — **Relaying the superstructure.**

1. Staking and marking out the run of the track.

Note :

Length of section from km. ... to km. ... . = ... km.
— — in curves . . . . = ... km.
— — on the straight . . . . = ... km.
Number of fixed boundary posts put up.

2. Building up the framework of the new track at the side.

Note :

Type of the new track . . . .
Number of sleepers in hard or soft wood, with sole plates, chairs, plates, etc. . . . .
Length of section from km. ... to km. ... . = ... km.

Appendix B.

Statistics relating to the work.

No. of the class of work.	Class of work.	Normal method of procedure.	Normal number of workmen.	Normal amount of work done.				
				Unit of measure.	Number of hours			
					For supervision.		For work.	
					Hours.	Minutes.	Hours.	Minutes.

Appendix C

Daily marking off of the ....

Ganger-days { *Less* .... *More* ....

State of atmosphere ....

Numbers of units composing gang.	PARTICULARS OF WORK. Quantity, nature, place. ABSENCES for holidays, with pay, and injuries in service.	From	to	Number of hours.	Number of workmen employed.	Total number of hours.	Reference.
					TOTAL. . .		

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Appendix C.

Return of interruptions in working.

Number of units.	NATURE AND CAUSE OF INTERRUPTIONS.	INTERRUPTION		Total hours.
		From	to	
			TOTAL . . .	

SUPPLEMENTS.					ABSENT, SICK, DETACHED, RESTING.	
Number of units.	CAUSES.	From	to	Number of hours.	Number of units.	CAUSE.
			TOTAL . . .			

Ganger's remarks, if any.

DATED . . . . 192 .

Ganger,

Appendix D.

Rules for filling in the report books on the Belgian State Railways.

FILLING IN THE REPORT BOOKS.

Article 1. — These note books must be filled in daily by the Chief Gangers or Foremen, and are supplied in various colours, as follows:

Brown, for gangs of undermen	Paid on the account of the ordinary budget.
Pink, for skilled workmen	
Green, for gangs of undermen	Paid on account of the special budget, the budget for order work, or for recoverable expenses.
Blue, for skilled workmen.	

These note books are made up once a fortnight.

PARTICULARS OF STAFF.

Article 2. — The composition of the brigade or gang to which the report book has reference is clearly shown on the first pages of the book, which give a list of names and particulars.

When a workman joins the gang in the course of any particular fortnight, his name is entered after the others, and in the « Remarks » column is written after his name: « Started the . . . . of . . . . »

In case a workman leaves definitely or temporarily, his name must not be struck off the list, his absence being accounted for in the columns for that purpose in the pages to the right of the note book.

The normal number of ganger-days inscribed at the head of the first page is the number of ganger days (including the head ganger) to which the gang is entitled according to its composition.

It should be noted that if a workman in the course of his general work, has to do part of his duties digging, etc., and the remainder at some other occupation (for instance, as gatekeeper) he must not be included in the calculation of the normal number of ganger-days except for the actual time he has worked for that particular gang.

DAILY REPORTING.

Article 3. — The workmen are listed in the daily reports under a number, by which they figure in the composition of the gang.

Article 4. — On the left hand side of the daily report is inscribed:

1° The normal number of men supplied for the work on the section entrusted to the gang;

2° The assistance furnished by the members of the gang to help a man classed as « unskilled workman ».

Article 5. — At the head of each daily report the head ganger or foreman must state the number of man-days on the day in question, his gang has completed compared with the number of ganger-days that he is normally entitled to.

He must also as simply as possible state the prevailing atmospheric conditions during the day, such as fine, frosty, snow, continuous rain, intermittent rain, fog, up to . . . . o'clock, etc.

Each horizontal space in column 2 of the daily report must relate to one piece of work done by the workmen whose individual numbers figure in column 1 of the same space.

Columns 3, 4 and 5 are for each horizontal space divided into two parts, in the upper one of which the working hours before the midday rest are indicated, and in the lower position the hours worked afterwards.

Column 6 shows the number of workmen taken from column 1.

Column 7 gives the product of the number of hours debitable as in column 5 by the number of workmen shown in column 6.

Column 8 is reserved for showing opposite each horizontal space the number of the article, and if necessary the nature of this article or other abridged indication, showing where at the end of the report book the reference corresponding to the horizontal space in question should be allotted.

The allocations should be filled in by the chiefs of the section.

ARTICLE 6. — As regards maintenance work, this should be indicated as to nature and quantity according to the wording stated in the appendix. The details relating to other work should be short and accurate, both as regards nature and quantity.

It is specially recommended that the time devoted to handling, transport, loading and unloading of material should be separated from the time allowed for the work properly so called.

ARTICLE 7. — The figures representing the workmen occupied on the same operation at the same time should be grouped together.

If other men have done the same work, but during other hours, they should be shown in the following spaces, so that it may be only necessary to write « id. » in column 2 « Indication of work done ».

ARTICLE 8. — In the table *List of interruptions in working* in the right hand sheet of the daily report, should be mentioned all details which have interfered with the work, especially:

1° Time lost in helping to pay wages;

2° Time lost in coming and going, in changing from one section to another, fetching tools, material, etc.;

3° Time lost through rain, snow or fog;

4° Time lost on account of passing trains and shunting operations. This should be estimated in bulk for each day for each gang.

The time shown on the left hand page includes that lost through interruptions to the work, and should always be charged to one of the jobs referred to on the left hand page.

ARTICLE 9. — In the table marked « Supplements », on the right hand page of the daily report should be shown all details for which additional pay is allowed.

1° Laborious and dangerous work (state in columns 3 and 4 the hours in which laborious or dangerous work has been done, mention must be made in column 5 of the table);

2° More important functions in the same gang, without any indication of the hours in columns 3, 4 and 5 of the table. For instance: underman ff. chief ganger or assistant fitter ff. fitter in the same gang;

3° Work done after the usual hours or on Sunday (complete particulars in columns 3, 4 and 5).

ARTICLE 10. — In the table « Absent, ill, etc. » should be written:

1° Absent workmen, resting or on holiday without pay;

2° Workmen who are ill;

3° Workmen who have been transferred to another job or to another gang. For instance, as temporary watchmen, gate keeping, etc., or detached as chief ganger in another gang;

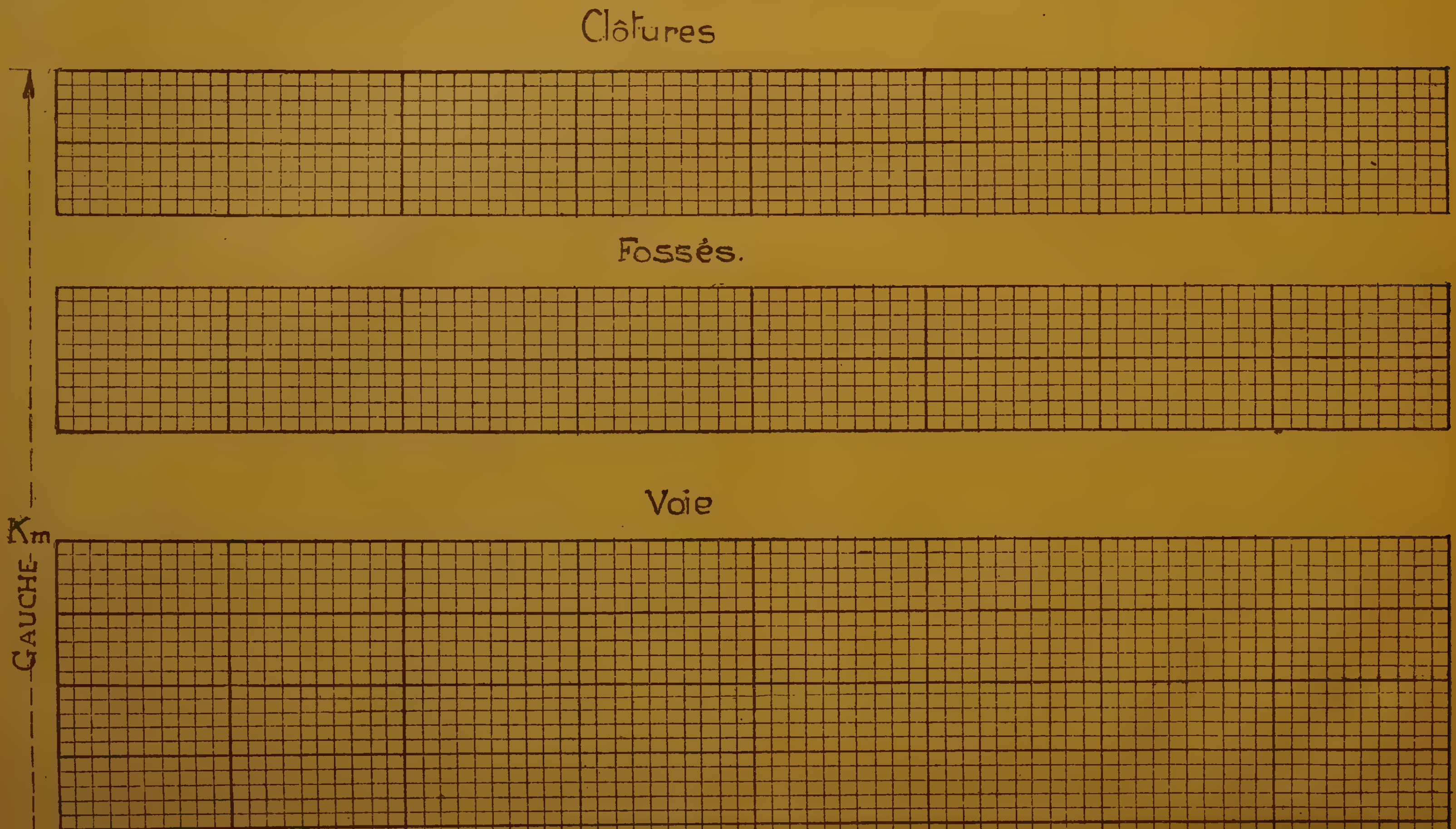
4° Workmen detached to take the place of others in another gang. For instance, transferred as skilled workman or transferred as ganger;

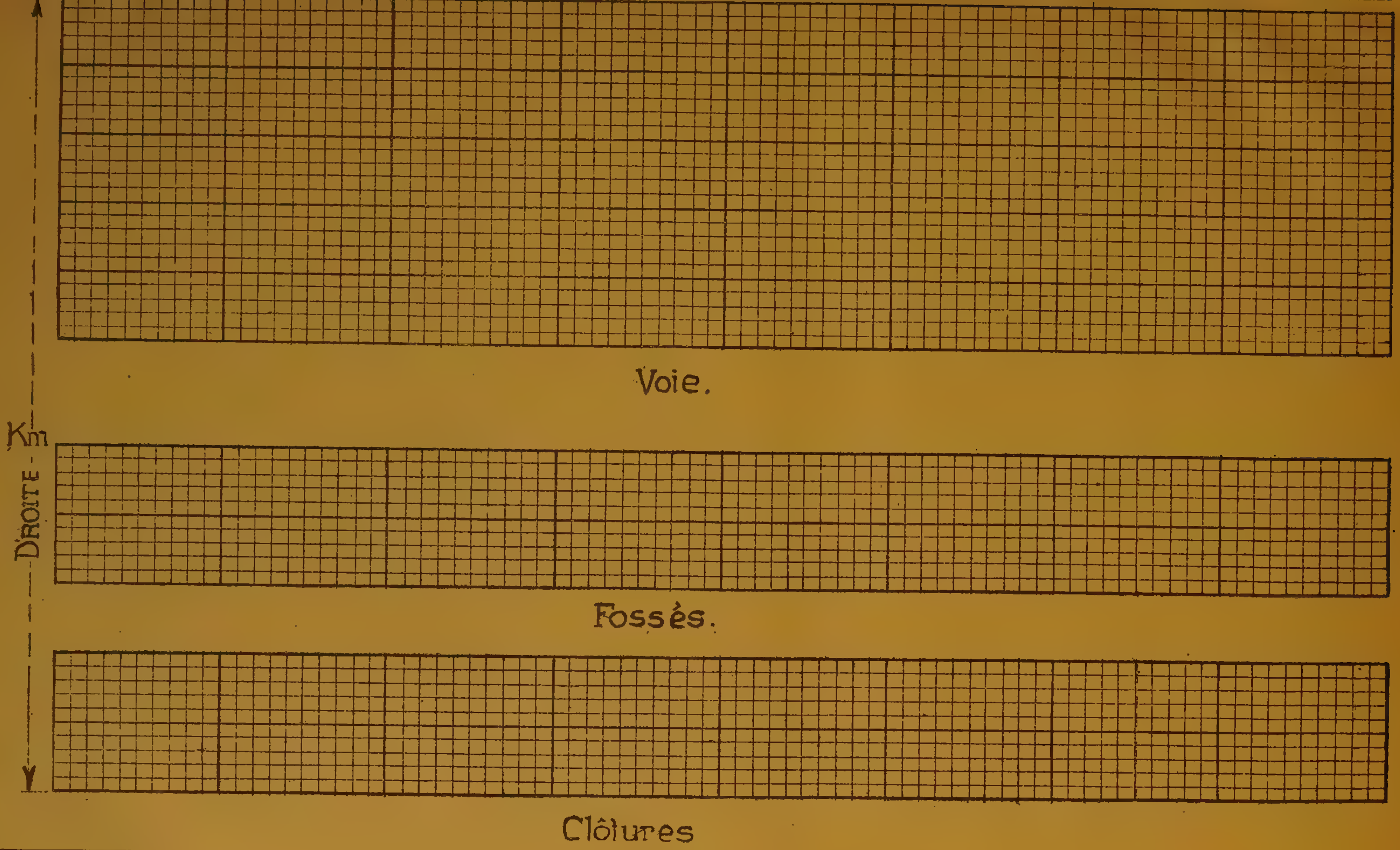
5° Workmen engaged on work paid on another account, and to whom are allotted a special report book.

ARTICLE 11. — The last pages of the report books are reserved for reference to the transfers made in the gang during the fortnight in question, and are filled in at the office of that particular section.

Appendix E.

Group of	**Line from** .... **to**	Year 19...
..... section.	*B.K*......... *A*.........	
...... sub-section.	*Gang No.*	
Ganger No.	.... *Head ganger.* + ...*Undermen.*	



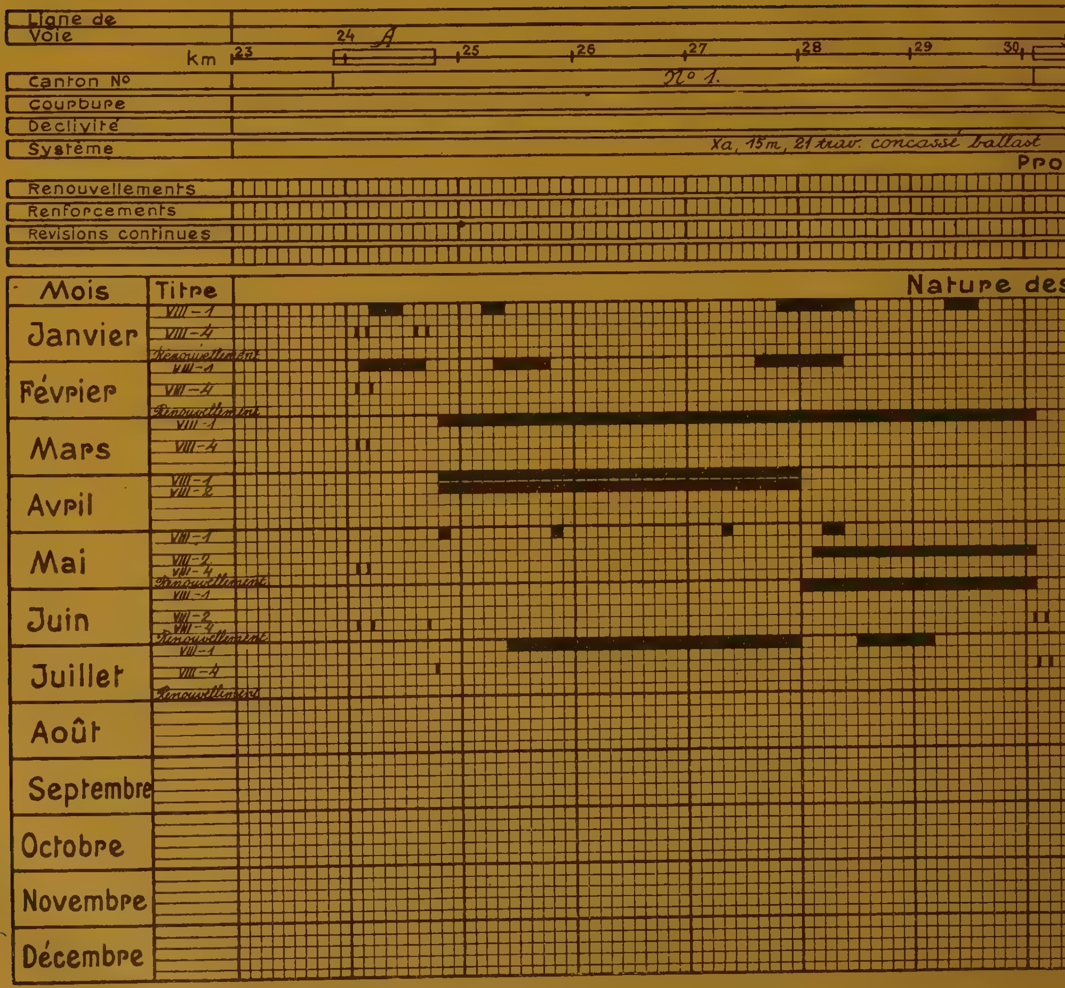


Translation of French terms : Clôtures = Fencing. — Fossés = Ditches. — Voie = Track. — Gauche = Left. — Droite = Right.

Section of ....

District No. .... *of* ....

Diagrammatic



Red	■	Normal upkeep.
Blue	▨	Renewals.
Yellow	▥	Continuous revision.
Green	▤	Strengthening.

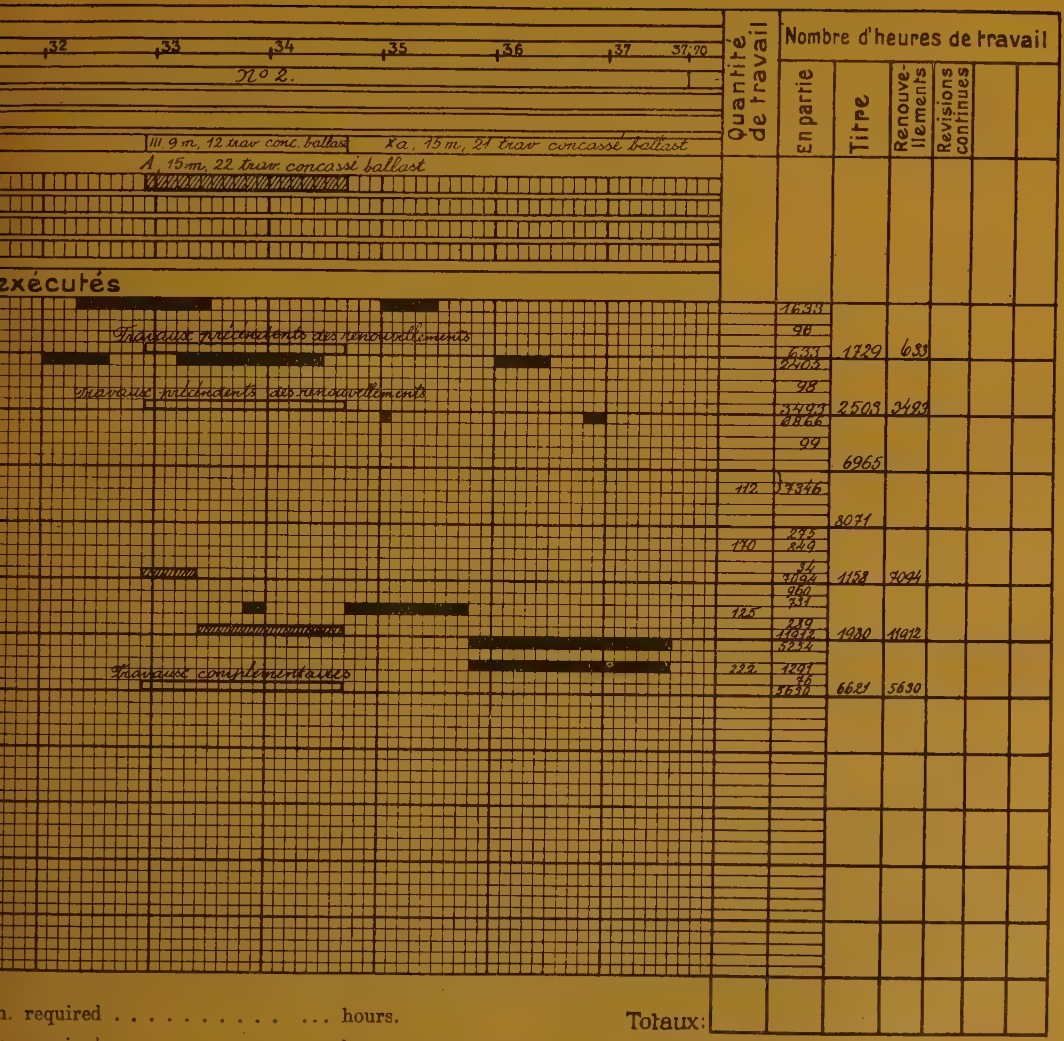
Length of single track = ...

Length of double track = ...

Renewal accomplished = ...

Translation of French terms : Ligne de = Line of. — Voie = Track. — Canton n° = Length No. — Courbure = Curve. —
continues = Continuous revisions. — Titre = Heading. — Nature des travaux exécutés = Nature of work executed.
de travail = Amount of work. – Nombre d'heures de travail = Number of working hours. — En partie = In parts.

intenance work.



n. required . . . . hours.
n. required . . . . hours.
n. required . . . . hours.

nt. — Xa, 15 m., 21 trav. concassé ballast = Sleepers, broken stone ballast. — Renouvellements = Renewals. — Revisions
dant des renouvellements = Work done before renewals. — Travaux complémentaires = Supplementary work. — Quantité

[385 .581]

REPORT No. 2

(All countries, except America, the British Empire, Switzerland, Italy, Spain and Portugal)

ON THE QUESTION OF THE EIGHT-HOUR DAY (SUBJECT X FOR DISCUSSION AT THE TENTH SESSION OF THE INTERNATIONAL RAILWAY CONGRESS ASSOCIATION), (1)

By Mr. SOULEZ,

CHIEF ENGINEER, NORTHERN RAILWAY OF FRANCE. (2)

INTRODUCTION.

The Treaty of Peace of Versailles.

Part XIII of the Treaty of Peace signed at Versailles on the 28 June 1919, after stating that « an improvement of the conditions of labour is urgently required : as, for example, by the regulation of the hours of work, including the establishment of a maximum working day and week », established, for the promotion of such objects, a permanent organisation comprising a General Labour Conference and an International Labour Bureau.

The General Conference has to prepare proposals, either in the form of « a recommendation to be submitted to the Members of the League of Nations for consideration with a view to effect being given to it by national legislation or otherwise », or in the form of « a draft international convention for ratification by the Members ». (Art. 405 of the Treaty.)

The task of the General Conference is defined in article 427 of the Treaty, which recommended as of special and urgent importance :

« the adoption of an eight hour day or a forty-eight hour week as the standard to be aimed at where it has not already been attained » (§ 4);

« the adoption of weekly rest of at least twenty-four hours, which should include Sunday wherever practicable » (§ 5).

The conditions of labour (§ 4) were examined at Washington in 1919, and the question of the weekly rest (§ 5) in 1922, at Geneva.

Washington Conference.

The draft Convention relative to the eight hour day, adopted by the Washington Conference, comprises the following main provisions :

INTERNATIONAL LABOR CONFERENCE.

ARTICLE 1. — For the purpose of this

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(1) This question is worded as follows : « The eight-hour day on the railways ».

(2) Translated from the French.

Convention, the term « industrial undertaking » includes particularly :

a) Mines, quarries, and other works for the extraction of minerals from the earth;

b) Industries in which articles are manufactured, altered, cleaned, repaired, ornamented, finished, adapted for sale, broken up or demolished, or in which materials are transformed; including shipbuilding and the generation, transformation, and transmission of electricity or motive power of any kind;

c) Construction, reconstruction, maintenance, repair, alteration, or demolition of any building, railway, tramway, harbour, dock, pier, canal, inland waterway, road, tunnel, bridge, viaduct, sewer, drain, well, telegraphic or telephonic installation, electrical undertaking, gas work, waterwork or other work of construction, as well as the preparation for laying the foundation of any such work or structure;

d) Transport of passengers or goods by road, rail sea or inland waterway, including the handling of goods at docks, quays, wharves or warehouses, but excluding transport by hand.

The provisions relative to transport by sea and on inland waterways shall be determined by a special conference dealing with employment at sea and inland waterways.

The competent authority in each country shall define the line of division which separates industry from commerce and agriculture.

ARTICLE 2. — The working hours of persons employed in any public or private industrial undertaking or in any branch thereof, other than an undertaking in which only members of the same family are employed, shall not exceed eight in the day and forty-eight in the week, with the exceptions hereinafter provided for :

a) The provisions of this Convention shall not apply to persons holding positions of supervision or management nor to persons employed in a confidential capacity;

b) Where by law, custom, or agreement between employers' and workers' organizations, or, where no such organizations exist between employers' and workers' representatives, the hours of work on one or more days of the week are less than eight, the limit of eight hours may be exceeded on the remaining days of the week by the sanction of the competent public authority, or by agreement between such organizations or representatives; provided, however, that no case under the provisions of this paragraph shall the daily limit of eight hours be exceeded by more than one hour;

c) Where persons are employed in shifts it shall be permissible to employ persons in excess of eight hours in any one day and forty-eight hours in any one week, if the average number of hours over a period of three weeks or less does not exceed eight per day and forty-eight per week.

ARTICLE 3. — The limit of hours of work prescribed in article 2 may be exceeded in case of accident, actual or threatened, or in case of urgent work to be done to machinery or plant, or in case of « force majeure », but only so far as may be necessary to avoid serious interference with the ordinary working of the undertaking.

ARTICLE 5. — In exceptional cases where it is recognized that the provisions of article 2 can not be applied, but only in such cases, agreements between workers' and employers' organizations concerning the daily limit of work over a longer period of time, may be given the force of regulations, if the Government, to which these agreements shall be submitted, so decides. The average number of hours worked per week, over the number of weeks covered by any such agreement, shall not exceed forty-eight.

ARTICLE 6. — Regulations made by public authority shall determine for industrial undertaking :

a) The permanent exceptions that may be allowed in preparatory or complementary work which must necessarily be carried on outside the limits laid down for the general working of an establishment, or for certain classes of workers whose work is essentially intermittent;

b) The temporary exceptions that may be allowed, so that establishments may deal with exceptional cases of pressure of work.

These regulations shall be made only after consultation with the organizations of employers and workers concerned, if any such organizations exist. These regulations shall fix the maximum of additional hours in each instance, and the rate of pay for overtime shall not be less than one and one-quarter times the regular rate.

ARTICLE 8. — In order to facilitate the enforcement of the provisions of this Convention, every employer shall be required :

a) To notify by means of the posting of notices in conspicuous places in the works or other suitable place, or by such other method as may be approved by the Government, the hours at which work begins and ends, and where work is carried on by shifts the hours at which each shift begins and ends. These hours shall be so fixed that the duration of the work shall not exceed the limits prescribed by this Convention, and when so notified they shall not be changed except with such notice and in such manner as may be approved by the Government;

b) To notify in the same way such rest intervals accorded during the period of work as are not reckoned as part of the working hours;

c) To keep a record in the form prescribed by law or regulation in each country of all additional hours worked in pursuance of articles 3 and 6 of this Convention.

It shall be made an offense against the law to employ any person outside the hours fixed in accordance with paragraph *a*), or during the intervals fixed in accordance with paragraph *b*).

ARTICLE 14. — The operation of the provisions of this Convention may be suspended in any country by the Government in the event of wár or other emergency endangering the national safety.

ARTICLE 15. — The formal ratifications of this Convention, under the conditions set forth in Part XIII of the Treaty of Versailles of 28 June 1919, and of the Treaty of St. Germain of 10 September 1919, shall be communicated to the Secretary General of the League of Nations for registration.

ARTICLE 18. — This Convention shall come into force at the date on which such notification is issued by the Secretary General of the League of Nations, and it shall then be binding only upon those Members which have registered their ratification with the Secretariat. Thereafter this Convention will come into force for any other Member, at the date on which its ratification is registered with the Secretariat.

ARTICLE 20. — A Member which has ratified this Convention may denounce it after the expiration of ten years from the date on which the Convention first comes into force, by an act communicated to the Secretary General of the League of Nations for registration. Such denunciation shall not take effect until one year after the date on which it is registered with the Secretariat.

ARTICLE 21. — At least once in ten years the Governing Body of the International Labor Office shall present to the General Conference a report on the working of this Convention, and shall consider the desirability of placing on the agenda of the Conference the question of its revision or modification.

It will be seen, then, that the Washington Convention, particularly in articles 2 and 6, specifies that the limit of eight hours per day or forty-eight hours per week, or any other equivalent limitation, applies to the performance of *actual* work, the period of attendance being subject to prolongation, as determined by regulations, « in the case of certain categories of persons whose work is largely intermittent » (art. 6, § *a*).

The period in excess of eight hours, applicable to employees (¹) whose work is of an intermittent nature, must not be considered as overtime; only « temporary exceptions which may be necessary to enable a business undertaking to cope with unusual increases of work » are to be regarded as overtime (art. 6, § *b*).

Further, by article 5, the Convention provides that for a given class of employees, the daily period of work may vary according to circumstances, the total number of hours worked being adjusted on an average for a longer period than one week.

If reference is made to the Report of the Director of the International Labour Bureau, issued on the occasion of the 6th session of the International Labour Conference, it will be seen that only three countries (Geneva, 1924), out of those referred to in the Report, have ratified the Washington Convention : these three countries are *Greece, Roumania* and *Czechoslovakia.*

Roumania did not undertake to apply the Convention until the 1 July 1924 (art. 13 of the Convention).

Under the terms of article 12 of the Convention, *Greece* (¹) was authorised, as regards certain groups of industries, to postpone to the same date the application of the provisions of the Convention, and announced her intention to take advantage of this authorisation.

Czechoslovakia is applying the Convention at the present time by virtue of a law voted in 1919.

The other countries referred to below have decided that they could not, for various reasons, bind themselves by outright ratification of the Convention, but they have nevertheless, in varying degrees, undertaken to take steps in the direction of limiting the working day to eight hours.

Belgium, for reasons connected with international competition, has not ratified the Convention, but she has none the less embodied its provisions in the law of the 14 June 1921, which instituted the eight hour day and the forty-eight hour week.

China has not yet accepted the principle of the eight hour day, and is only prepared, as a first step, to contemplate a limit of ten hours for certain industries.

Denmark, while in practice observing the principle of the eight hour day, has not embodied it in a legal enactment.

(¹) Where mobile staff is referred to, this includes drivers, firemen, guards, brakesmen or any other grades employed on moving trains.

Where stationary staff is referred to, this includes ll grades other than the a bove.

(¹) The information given in this report with regard to the regulations in force in Greece was supplied by the General Management of the Greek State Railways in February 1924.

Up to December 1922 this limitation was effected by a collective agreement entered into between the employers and the Trade Union Federation.

This collective agreement has been cancelled and replaced by individual agreements based on the same principles.

Although she has not yet ratified the Convention, *France* instituted the eight hour day by the law of the 23 April 1919, the essential principles of which law were reproduced in the Washington Convention.

The Government of the Grand Duchy of Luxemburg is considering the possibility of adhering to the Franco-Belgian Convention, which reproduces the terms of the Washington Convention.

Norway, although not yet having decided to ratify the Convention, has nevertheless progressively introduced the eight hour day and the forty-eight hour week, as regards periods of actual work, at any rate on the railways.

Since the 1 January 1920 the forty-eight hour week has been applied to all categories of employees working under special regulations which differentiate between actual work and mere attendance, the latter only counting for a fraction of the former in calculating the total work.

Holland, by a law of the 20 April 1922, amending the law of the 1 November 1919, substituted the eight and a half for the eight hour day, the maximum annual period of actual work being fixed at 2 500 hours.

The new legislation, prompted as in the case of Belgium by reasons connected with the question of international competition, is, however, in accord with the general provisions of the Convention.

Sweden, in February 1923, while introducing amendments on the subject of overtime work, prolonged for a further period of three years the provisional law of the 22 June 1921, which instituted the eight hour day, and which was to lapse on the 31 December 1923.

As regards *Japan,* we only possess information regarding the application of the eight hour day to the railways, and not to other industries. The railways belonging to the State and to private companies have not yet completely instituted the eight hour day, which up to the present has not been given the force of legal sanction; in a certain number of services, however, an analagous system has been introduced.

It is interesting, for the purpose of record, to notice here the attitude taken up by *Germany* towards the Washington Convention.

After the Government had decided, in 1921, in favour of ratifying the Convention, the *Reichsrat* decided, in October 1922, to postpone any decision on this subject.

In October 1923 a bill concerning the hours of labour of workmen engaged in industries passed its first reading before the special commission of the Reichsrat, but was then withdrawn.

This bill, which derived its inspiration from the Washington Convention, was intended to extend (and at the same time to render more elastic) the Government orders of 1918 and 1919 instituting the eight hour day for workmen and employees.

As these orders lapsed in November 1923, the Government passed a provisional order which came into force on the 1 January 1924, to regularise the situation until such time as final legislation can be passed.

The provisional order adheres strictly to the principle of the eight hour day, but it admits a whole series of exceptions, of an extremely extensive character, which are explicitly provided for in the text, or which can even arise from agreements between employers and employed, or from decisions made by competent authorities.

Certain provisions of the provisional order are, therefore, in opposition to the clauses of the Washington Convention, so that the limitation of the period of actual work to eight hours is now subject to very numerous exceptions.

At the end of the present Report will be found a concise analysis of the regulations with regard to labour at present in force on the German State Railways.

Geneva Convention.

The Geneva Convention (1922) concerning the application of the weekly rest in industrial concerns stipulates, in article 2, that the whole of the staff employed in such concerns shall be allowed a rest of at least twenty-four consecutive hours in each period of seven days.

According to the Report presented by the Director of the International Labour Bureau to the International Labour Conference held at Geneva in 1924, the Convention relative to the weekly rest has up to the present been ratified only by *Roumania* (18 August 1923) and *Czechoslovakia* (31 August 1923), out of the countries dealt with in the present report.

In *Greece* and *Poland* Parliament has authorised the ratification of the Convention.

The *Dutch* Government has recommended the ratification to Parliament, and has introduced a bill reserving to the Crown the right to ratify this Convention.

In *Belgium, Denmark* and *France* the Government has drafted a bill approving ratification.

Japan has decided not to ratify the Convention for the present in view of the fact that in the majority of industrial concerns it is the custom to allow only one or two rest days per month.

In *Poland* the Convention, the ratification of which has been authorised, has actually been put into effect under certain legislative provisions concerning working hours.

In *Roumania* the régime contemplated by the Convention has been in existence since 1910, in which year a law was passed instituting the weekly rest day.

In *Sweden* the Government and the Parliament have apparently not yet decided to ratify the Convention, but they are considering the possibility of generalising the weekly rest.

The *Czechoslovakian* law relative to labour conditions (19 December 1918) provides that a weekly rest of thirty-two consecutive hours shall be allowed to all employees, preferably including Sunday; and, in enterprises in which work is continuous, arrangements must be made whereby each employee is given a Sunday rest at least once in every three weeks.

Former regulations. — Consequences of the adoption of the eight-hour day.

It appeared to us that it might be useful, after having indicated the position in each country as regards the Washington and Geneva Conventions, and before studying the regulations at present adopted by the railway industry in the various countries, to note the principal characteristics of former regulations, whether such regulations have lapsed or are still in force, and to remark the methods by which the eight hour day or the weekly rest has been substituted for a different régime formerly existing.

This will enable us, as regards certain countries, to indicate the additional expenditure, in men and money, necessitated by the introduction of the eight hour day.

In *Belgium* the limitation of the daily period of work to eight hours was effected prior to the passing of the law of the 14 June 1921, whenever it was possible to recruit the necessary number of additional employees. (The question of this additional staff will be referred to again later.)

In effect the eight hour day was practically in force in the locomotive Department as from the 1 October 1919, and in the Station and Line Service as from the 1 May 1920, that is to say, thirteen months prior to the passing of the law.

Under the system in force previous to 1919, the daily period of work could extend to as much as thirteen hours in the case of drivers and firemen, with a weekly rest which might be as low as eight hours, whether at or away from the place of residence, and which might extend to fifteen or sixteen hours.

In small or average size stations the working day could extend to twelve hours, and in engine sheds and workshops to ten hours.

In the great majority of the establishments belonging to the Locomotive and Traffic Departments, the work now done by three shifts of eight hours each was done by two shifts each working twelve hours per day.

Employees of the Permanent Way Department normally worked ten hours a day, with a maximum of from twelve of fourteen hours. Gatekeepers (whether housed or not) at busy points worked 12 hours a day; at less busy points the period might extend to as much as 14 hours.

As a general rule the staff were granted 28 rest days per year with pay, which in practice amounted to 1 Sunday in 2.

The application of the new régime has led to a general increase of staff amounting to 14 975 employees, divided into categories as follows :

CATEGORIES OF EMPLOYEES.	Traffic Department.		Locomotive Department.		Way and works Department.		Goods Department.	
	Increase		Increase		Increase		Increase	
	absolute.	relative.	absolute.	relative.	absolute.	relative.	absolute.	relative.
		Per cent.		Per cent.		Per cent.		Per cent.
Assistant station-masters. .	47	32	...	...	...	...	...	...
Clerks and bookkeepers . .	642	33	125	25	25	8	124	26
Porters, etc.	1 805	54	62	21	10	19	...	...
Railway police	32	43	...	...	...	...	...	...
Head guards and guards . .	1 028	30	...	...	...	...	...	...
Platelayers	...	...	...	...	60	24	...	...

On the *Prince Henri Railway* the eight hour day has been in force since 1919 for the whole personnel of stations, depots, workshops and permanent way.

Before the introduction of the eight hour day the position was as follows :

1° *Train staffs :* 12 hours' work per day — 52 rest days per year — 8 to 15 days' holiday with pay;

2° *Drivers and firemen :* 12 hours' work per day — 52 rest days — 8 days' holiday with pay;

3° *Station staffs :* 10 hours' work per day — 52 rest days — 8 to 15 days' holiday with pay;

4° *Workshop and permanent way staff:* 10 hours' work per day — 52 rest days (unpaid) per year — no yearly paid holiday.

The introduction of the new régime necessitated an increase of personnel which, for the railway as a whole, may be estimated at from 30 to 33 %.

In *Holland* the former regulations provided, as a general rule, for a maximum of 16 hours' work on any one day, provided, however, that the total period of work, during four consecutive weeks, did not exceed 280 hours in the case of drivers and firemen, 308 hours in the case of train staffs, and, during two consecutive weeks, 168 hours in the case of employees on the permanent way.

The minimum daily rest was fixed at 10 hours; workshop staffs worked 9 3/4 hours, which period, together with two breaks, was not to exceed 12 hours.

Regulations adopted as a result of the issue of the Decree of the 29 December 1919 provided, in the case of station staffs engaged on continuous work, for a daily maximum of 10 hours' work, subject to a maximum for two consecutive weeks of 96 hours for office staff and 102 hours for the remainder. The corresponding limits were 12 hours and 102 hours for mobile staff; 12 hours and 144 hours for permanent way inspection staff housed in proximity to their place of work; 12 hours and 132 hours for permanent way inspection staff not housed near to their place of work; 10 hours and 114 hours for other employees. The Minister was, moreover, empowered to reduce the above maxima in the case of the Traffic and Locomotive staff to 8 hours per day and 90 hours per period of two consecutive weeks. The institution of this régime necessitated the following increases of staff :

Drivers, firemen and train staffs	1 921	employees.
Staffs of stations and depots.	2 660	—
Permanent way staff . . .	1 000	—
Workshop staff	426	—
Other employees	8	—
	6 015	employees.

It was possible to reduce this additional staff as a result of the new regulations dated 9 March 1922, the principal points of which are set out below.

On the *Swedish State Railways* the regulations formerly in force can be summarised as follows :

a) Workshop staffs	9 hours work per day.
b) Station and depot staffs and locomotive staff .	10 hours (average) per day (or 9 hours in the case of night work.)

The period of work might be increased to as much as 11 hours in the case of the inspection staff, or reduced to 9 hours for the more arduous branches of the service, or to 8 hours in the case of pointsmen or shunting staffs.

c) Permanent way employees	10 hours (average) per day.
d) Train staffs	250 hours per month of 30 days.

The new system having been introduced at a time (1 July 1920) when the diminution in traffic had rendered a certain number of employees superflous, it has not been possible to estimate the actual increase attributable to the introduction of the eight hour day.

On the *Nora* railways the increase of staff is estimated at from 10 to 15 %.

In *Denmark*, prior to the agreement of the 28 June 1919 entered into with the staff organisations, there were scarcely any regulations with regard to the period of work, which varied according to the categories of the staff and according to the district. It is understood, however, that before the war the average working hours were 9 h. 6 m. for head stationmasters, 11 h. 12 m. for assistant stationmasters, 8 h. 48 m. for traffic employees, 9 h. 18 m. for porters, 8 h. 30 m. for train staffs, and from 6 to 7 hours for office staff.

Male gatekeepers worked from 12 to 16 hours, and at certain posts the husband and wife had to divide the whole 24 hours' work between them. The depot staffs worked from 9 to 10 hours per day, and the permanent way staff from 8 1/2 to 10 hours, according to the season.

In the case of engine crews a limit of 208 hours per month (an average of eight hours a day for 26 working-days) has been adopted instead of the limit of 235 hours imposed by the regulations introduced in 1917.

As a result of the reduction of working hours, it has been necessary to resort to paid overtime work and to engage additional staff.

In November 1922, however, the regulations with regard to working hours, the weekly rest and overtime were modified in such a way that a certain number of employees at present work 9 hours instead of 8.

On the *large French railways* the position prior to the introduction of the eight hour day legislation was the following :

a) *Drivers and firemen.* — Prior to the decrees of 1919 *the daily average of actual work*, between two main periodical rest days, could not exceed 10 hours; *the maximum period of attendance at the place of work* was fixed at 15 hours per day, or 16 hours if it included breaks amounting to at least 4 hours; *the maximum number of working days* between two successive rest days was fixed at 15; *the minimum length of the main periodical rest days* was 30 hours, or, as an exception, 24 hours in the case of employees whose work did not necessitate their sleeping away from home; *the minimum length of the daily period of rest* was 10 hours for employees living at home, or 7 hours for employees working away from home, and, further, the total of two consecutive periods, of rest, in the case of employees working away from home, had to be at least 17 hours. Finally, the main periodical rest day was supposed to terminate about 4 a. m. at the earliest, but there was no regulation fixing the hour of commencement.

Reserve duty counted for a quarter in work between the main periodical rest days and for three-quarters in the total rests in 9 days (total of at least 90 hours);

b) *Train staffs.* — Prior to the decrees of 1919 *the daily average of actual work* between two main periodical rest days could not exceed 10 hours (11 in the case of employees not employed away from their homes); *the maximum period of attendance at the place of work* was fixed at 17 hours; *the maximum duration of actual work in a working day* (comprised between two consecutive main rest days) was fixed at 12 hours (12 1/2 hours provided the following rest day taken at home was of at least 12 hours' duration); *the maximum number of working days* comprised between two consecutive periodical rest days was fixed at 15; *the minimum length of the main periodical rest days was 24 hours; the minimum length of the daily period of rest* was 9 hours at the place of residence or 7 hours away from the place of residence.

There were no regulations with regard to the interval between the main periodical rest days, nor with regard to the hour of commencement and termination of these rest days.

Reserve time at a station counted as actual work for a quarter of its duration.

In calculating the period of actual work, the time spent on trains scheduled as fast passenger trains fast or through goods trains (« grande vitesse » or « petite vitesse »), as well as on engines running light, counted for 9/10ths of its duration.

For the rest, the regulations contained provisions similar to those of the 1919 decrees.

c) *Other employees.* — As regards employees other than those referred to above, the higher administration had not formulated any regulations except in the case of the employees of stations, shunting yards and halts (whose work might be considered as connected with the safe running of trains) on the one hand, and in the case of employees engaged in the inspection, upkeep or repair of the permanent way, signalmen, and permanent gatekeepers, on the other hand.

For employees coming under these regulations, the maximum length of the working day was fixed at 12 hours; the minimum length of the daily rest period was 9 hours for employees without railway houses or 8 hours for employees residing in railway houses.

Every employee had the right each month to one whole day or two half-days' rest; not more than two rest days in respect of two consecutive months might be combined, but in no case could there be a period of two months without a rest day. In practice the railways did not take advantage of this regulation minimum, but granted all their employees, other than those engaged on intermittent service, 52 days' rest per annum.

The maximum number of consecutive nights of work was fixed at 14, in the case of employees working alternate night and day periods.

Arising out of the law of the 23 April 1919 a decree of the Minister of Public Works instituted a commission « to consider the measures to be taken, whether from the technical or the administrative point of view, in connection with the introduction of the 8 hour day on the railways ».

No less than 43 resolutions were passed at the meetings of this commission, fixing temporarily (¹) the various working conditions of the mobile and stationary staffs.

In addition the Minister issued decrees, dated 8 November 1919, with regard to the mobile staff of the Traffic and Locomotive Departments; these decrees are still in force, and supplement the resolutions of the commission referred to above.

The principal features of the conclusions adopted by the above commission were :

a) the rigorous application of a daily maximum of 8 hours' service without any distinction between mere presence and actual work, except in the case of a very

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(¹) Pending the issue of a decree laying down final regulations.

small number of categories of employees (1);

b) these 8 hours were to be divided into not more than two parts by a break which when added to the 8 hours should not exceed a strictly limited duration;

c) any overtime work demanded from employees outside the limits of the regulations was to be compensated for by the granting of an equivalent period of rest.

The results of the application of this « régime » were described in the report presented to the Higher Council of Railways by the Inspector-General M. Mussat, on the 14 June 1922, in connection with the preparation of the decree of the 14 September 1922, the provisions of which were to take the place of the temporary provisions adopted in 1919.

« In 1913 », writes Mr. Mussat, « the « personnel of the 6 main railways comprised 352 045 employees; compared « with the number of train-kilometres « and with the number of traffic units « (*i. e.*, the total of passenger-kilometres « and ton-kilometres) the number of employees works out at 0.88 per 1 000 « train-kilometres (1.42 per 1 000 train-miles) and at 0.79 per 100 000 traffic « units.

« In 1920, a year which was entirely « subject to the « régime » instituted by « the special commission, the personnel « increased to 493 263 employees, or 1.86 « per 1 000 train-kilometres (3.0 per « 1 000 train-miles) and 1.0 per 100 000 « traffic units. The output of the personnel thus showed a decline of 112 % « on the basis of train-kilometres or of « 28 % on the basis of traffic units.

« In 1921 a more extensive experience « of the eight hour day system made it « possible to improve the organisation; « the number of employees worked out « at 1.62 per 1 000 train-kilometres (2.61 « per 1 000 train-miles) and at 0.95 per « 100 000 traffic units; as compared with « 1913 the output of the staff had declined by 84 % and 19 % respectively.

« The actual decrease in output is a « figure somewhere between these two « limits; it manifests itself in the fact « that, from 1913 to 1921, in spite of the « reduction in traffic, the total number « of employees of the large railways increased by 110 800. »

The author of the report then shows, by concrete examples, the reduction in output in stations, *e. g.* « At Angers, an « important station on the Paris-Orleans « Railway, the number of employees increased between 1913 and 1921 by 31 %, « whereas the number of tickets issued « only increased by 4.6 %, and on the « other hand there was an actual reduction in traffic (13 % in the number of « trains, 33 % in the tonnage of goods « carried); in a very small station where « traffic has appreciably diminished « while the « commercial » operations « have shewn little variation, the number « of employees has increased by 80 %.

« The same results are observed as regards pointsmen; at an important « centre on one of the large railways the « number of pointsmen increased by « 75 % while the increase in train movements only increased by 44 %; at a « small center on the same railway, two « employees are now required for the « passage of 14 trains, whereas in 1913 « a single employee dealt with 16 trains.

« Finally, on the same railway, the decline in output as compared with 1913, « in the workshops and engine depots, is « as follows :

« 25 % for the large workshops taken as a whole;

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(1) Signalmen, gatekeepers, caretakers, night watchmen.

« 23 to 27.5 % for the engine depots;
« 18 to 28.5 % for the repair shops;
« 32.5% for the warehouses and stores.

« A further example of the decline in output : at *Paris-Nord* the number of booking-office windows increased by 30 % and the number of employees by 90 % during normal periods (113.9 % during the summer season), whereas the density of traffic only showed an increase of 11 %).

« From the financial point of view the application of the eight hour day has had disastrous effects upon railways; the increased expenditure on staff, excluding drivers, firemen and train staffs, amounts to 676 000 000 francs. »

Mr. Mussat, whose report was adopted by the Higher Council, concluded that it was essential to improve the output of the staff, while complying with the legislation in regard to the eight hour day.

Following on the propositions put forward in this report, a decree was issued on the 14 September 1922, the provisions of which (summarised in the present report) were to remain in force until the beginning of 1925, at which date they were replaced by the more restrictive provisions of the decree of the 16 January 1925 (also summarised in this report).

As regards the mobile personnel, the decree intended to replace the decrees of the 8 November 1919 is at present in course of preparation.

The legislation instituting the eight hour day was applied to the light railways and tramways of France during the years 1919 and 1920, generally *en bloc* and after discussion between the companies and the employees, the agreements thus arrived at being subject to ratification by a Prefectoral decree.

The increase in the number of employees resulting from the adoption of the eight hour day is illustrated by the following examples; the Tramways Company of the Indre Department employed per 100 train-kilometres (per 100 train-miles) per day :

—	In 1913.	In 1923.
In the workshops . . .	2.66 (4.28)	4.5 (7.2)
On the permanent way.	6 (9.7)	12.5 (20.1)
At stations	5.5 (8.8) employees.	9.4 (15.1) employees.

In the case of the mobile staff, the increase is about 33 %.

On the railways of the Tarn Department the average increase in the number of employees is 15 %, and on the Ain railways about 20 %.

On the railways of the *Czechoslovakian Republic* the regulations in force prior to the introduction of the eight hour day (1919) were the following :

— average length of working day : 11 hours on main lines, with a possible maximum of 16 hours on secondary lines;

— minimum rest period at place of residence : 12 hours;

— minimum rest ditto away from place of residence : 6 hours.

The average increase in the number of employees resulting from the application of the eight hour day legislation is estimated at about 17 %.

On the *Railways of the Norwegian State* the principle of the eight hour day was adopted as from the 1 January 1920 following on the parliamentary resolution of the 18 July 1919. The regulations then drawn up were subsequently revised on the introduction of the present régime on the 15 May 1923.

The reply to the list of questions does not furnish any indication as to the additional expense occasioned by the introduction of the eight hour day.

Analysis of regulations at present in force.

In our analysis of the regulations at present in force we shall follow the principle which underlies the organisation of railways, the staff of which may be divided into two main categories :

1° Mobile staff of the Traffic and Locomotive Departments (drivers, fireman and train staffs);

2° Staff of the undermentioned services :

a) stations and depots;
b) permanent way (maintenance and inspection);
c) workshops.

We think it advisable to point out again that our report deals with the whole of the countries which were to be the subject of our investigations, although all those countries have not adopted the eight hour day, *China* and *Japan* in particular.

The reporter originally nominated to study the regulations adopted by the countries in question for the control of labour conditions, sent out a list of questions in 1923 to the different railway administrations, and the replies received to those questions will be analysed in the following chapters.

MOBILE STAFF OF THE TRAFFIC AND LOCOMOTIVE DEPARTMENTS.

(Drivers, firemen and train staffs.)

With very few exceptions, all the various sets of regulations lay down limits in respect of the following factors :

1° Periods serving as a basis for calculating the average daily work;
2° Limits of the working day;
3° Maximum duration of daily work;
4° Duration and frequency of periodical rests;
5° Duration of daily rests;
6° Length of journeys. Night work.

After having considered these different points, we shall give some particulars with regard to the methods of calculating the amount of « actual work ».

As a general rule regulations are uniformly applied to all employees engaged in connection with the running of trains (drivers, firemen, head guards) (1), as well as to brakesmen or employees engaged in sorting and distributing parcels during journeys.

In the somewhat rare cases in which the regulations applicable to train staffs differ from those applicable to drivers and firemen, special reference will be made to the facts in the ensuing part of the report.

1° Period serving as a basis for calculating the average daily work.

The period taken as a basis in calculating the average daily work varies considerably under the different sets of regulations at present in force on different railways.

The minimum period adopted for the purpose of this calculation is met with on the *Dutch* and *Roumanian Railways*, which have adopted the week as basis.

The same applies to a certain number of French light railways and to the « Société des Transports en commun de la région parisienne ».

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(1) On the large French railways the regulations at present in force do not make any distinction between steam engines and electric locomotives as regards the treatment of their staff.

The *Polish State Railways* have also adopted the week as the basis for calculating the limits of work, which are fixed at 46 hours for any period of seven days.

In the case of the *large French railways*, the basic period cannot at present exceed 10 days (¹).

The regulations of other administrations are wider, and take as the basis of calculation a round number of weeks (*Holland*, 2 weeks; *Belgian State*, 3 weeks; *Czechoslovakia* (²) and *Luxemburg*, 4 weeks; *Norway*, 4 to 6 weeks).

Other administrations adopt a round month of 30 days as basis. On this basis *Denmark* (³), *Sweden* and *Jugoslavia* provide for 208 hours' work per month.

On the Japanese State Railways the work of the mobile personnel is organised in rotation, the length of each turn varying from 2 to 20 days (on an average 10 days). There is no theoretic limitation of the average daily work, but in practice this average works out (on the basis of the figures for the whole of the State Railways in December 1923) at :

8 h. 6 m. for drivers and firemen,
8 h. 50 m. for train staffs,

including the operations to be effected before departure and after arrival (cleaning and stabling of engines, inspection of trains, etc.).

2° Limits of the working day.

The length of the working day, that is to say the period between commencing and finishing work, varies greatly in different countries. It reaches its maximum in *Roumania* with 24 hours, thus counterbalancing in a very large degree the restrictions imposed by the very limited basic period adopted for calculating the average daily work.

The minimum period is found on the *large Belgian, Dutch* and *French* railways, where it must not normally exceed 12 hours. In the case of these railways, however, it is permissible to increase this limit to 14 hours on not more than 2 days out of the basic period (¹).

3° Maximum duration of daily work.

The maximum amount of actual work which may be required within the limits of the working day is also very variable. The minimum is 9 hours in the case of the *large French railways* (with a permissible increase to 10 hours twice between two consecutive rest periods); 10 hours on the *Belgian* and *Danish Railways*; 12 hours in *Roumania, Norway* and *Greece*; 13 hours in *Sweden*; 14 hours in *Luxemburg* and *Jugoslavia*; and, finally, 16 hours on the *Czechoslovakian* and *Japanese* railways, which adopt the same limits for the amount of actual daily work as for the limits of the working day.

In *Holland* the normal maximum is 12 hours, with the possibility, in each period of 14 days, of working four stretches of 14 hours each in the case of drivers and firemen, or two such stretches in the case of train staffs.

4° Duration and frequency of periodical rests.

The main periodical rests (which do not always coincide with the expiration of

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(¹) A new set of regulations for the mobile personnel is at present in preparation.

(²) With a maximum of 192 hours actual work.

(³) On the Danish State Railways the drivers of locomotives who work without a companion only work 195 hours per month instead of 208.

(¹) Permission to work 14 hour stretches is only granted on the large French railways in the case of drivers and firemen, and not in the case of train staffs.

the basic periods adopted for calculating the average daily work) are separated by intervals the normal duration of which varies from 6 days (*Norway*) to 20 days (*Greece*), the regulations of most railways providing for an interval in the neighbourhood of from 7 to 10 days.

The length of these periods of rest is generally equal to the normal length of the nightly rest plus 24 hours; that is to say it is practically equal to 36 hours; the rest period generally comprises one whole calendar day and the better part of the nights preceding and following such calendar day.

In *Czechoslovakia* the minimum length of the rest period is 32 hours, once in every three weeks; in *Roumania* the normal length of the rest period in the case of drivers and firemen is 24 hours.

In *Norway* the period is only 30 hours, which may be reduced to 20 hours where necessary in the interests of the service, or even to less than 20 hours provided the employees agree.

On the *large French railways*, the average length of 36 hours is exceeded, since the main periodical rest, which must be given at the place of residence on an average once in every six working days, must be of at least 38 hours' duration. Further, this rest period must extend over two successive nights, the first beginning at latest towards 10.0 p. m. and the second ending not earlier than 6.0 a. m.; two of these rests may be combined in a single rest period of a minimum duration of 62 hours (38 + 24).

On the *Belgian State Railways* the periodical rest must be of at least 34 hours' duration, beginning in principle at 8.0 p. m. and not ending before 6.0 a. m., and comprising whenever possible Sundays and public holidays.

In the regulations of other administrations there do not appear to be stipulations with regard to the length of the periodical rest, or the hours at which it is to begin and end.

5° Duration of daily rests.

The length of the daily rest periods, that is to say the periods which separate two consecutive working periods, generally varies according as these rests are taken at or away from the place of residence. Rests granted to employees when away from their place of residence are almost always shorter than those granted when they are at home, the difference being justified by the necessity of shortening as far as possible the period of absence of such employees from their depots and from their families.

Exceptions to this rule occur in the case of certain countries such as *Holland, Belgium, Roumania*, where the length of the rest period is the same whether taken at or away from the place of residence (8 hours in *Belgium*, 12 hours in *Holland*, 6 hours in *Roumania*).

In *Japan* the length of the daily rest period is dependent on the nature of the service performed; for instance, it is 10 hours after a night's work, 24 hours after three consecutive nights' work, 12 hours after a day's work and 15 hours after a period of at least 14 hours' actual continuous work.

The minimum length of *rest periods taken at the place of residence* is 6 hours in *Roumania*, 9 hours in *Sweden* (1), 9 to 10 hours in *Greece*, 10 hours in *Czechoslovakia*, 8 or 9 hours in *Denmark*, 12 hours on the *Belgian State Railways*, and reaches the maximum of 14 hours in *France*, where the regulations only contemplate the possibility of descending as low as 13 hours once between two consecutive main periodical rests in the case of train staffs, and once to 13 hours and once to 12 hours between two such rests in the case of drivers and firemen.

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(1) In *Sweden*, if two successive days comprise a total of more than 24 hours' service, the employee must be given a rest period of at least 16 hours at his place of residence.

The minimum length of *rest periods taken away from the place of residence*, under French regulations, is 9 hours, with a permissible reduction to 8 hours when it is necessary to bring back the employee to his home. In the other countries the length of these rests taken away from home is generally shorter (*Luxemburg* and *Belgium*, 8 hours; *Greece* and *Sweden*, 7 hours; *Denmark* and *Czechoslovakia*, 6 hours).

On the Swedish Railways rests taken away from home may be reduced at the request of the employee.

We have seen that in order to reduce to a minimum the time during which an employee is absent from his depot, the length of rests taken away from home is generally shorter than that of those taken at home.

In certain countries the regulations, with a view to achieving the same object, also provide for :

a) either the limitation of the number of consecutive rests taken away from home,

b) or the limitation of the total number of hours of absence during a given period.

For example :

a) On the *large French railways* the prolongation of absence from home is limited by the obligation to arrange that every rest period taken away from home shall be followed by one taken at home, the only exception to this rule being in the case of drivers and firemen, who may when necessary take not more than two consecutive rest periods away from home. This restriction, in the majority of cases, renders it impossible to arrange triangular rotation, by which arrangement it was formerly possible to avoid unoccupied journeys of employees when there was a disproportion between the amount of traffic in the two directions;

b) Under the *Belgian* regulations no mobile employee of the Locomotive or Traffic Departments may be kept away from home for more than 340 hours during any one month.

6° Other limitations.

a) *limitation of length of journeys.*

With very rare exceptions, the regulations in force do not stipulate any maximum for the distance which train staffs can be called upon to travel between two consecutive daily rests.

b) *limitation of night work.*

On only two or three railways is there any restriction with regard to the number of hours of night work. Such restriction (where it exists) and the definition of « night work » are, moreover, not uniform.

On the *Belgian State Railways*, for example, the rotations are arranged in such a way that an employee is not called upon to work more than 15 nights per month.

On the *Polish State Railways* the number of hours of night work during a period of two weeks (the basic period on which the daily 8 hour average is calculated) must not exceed the number of hours of day work. Also, employees cannot be called upon to work for more than three consecutive nights (or six in cases of emergency).

In *Roumania* this limit of three consecutive nights is also observed (in principle).

In *Japan* employees who, as an exceptional occurrence, work more than three consecutive nights, are entitled immediately after to a rest of at least 24 hours.

Calculation of actual work.

After having examined the limitations adopted with regard to the daily or periodical duration of actual working and to daily or periodical rests, it is necessary to examine the regulations adopted for calculating the period of « actual work », that is to say the rules laid down for distinguishing between the period during which an employee is actually occupied (*e. g.*, time spent on a train journey, in preparing the locomotive for the journey, in taking it back to the engine shed or overhauling it, in acting as brakesman, or dealing with parcels), and the period during which he is merely in attendance, *i. e.*, the time during which he is available if required, as for example when awaiting at the engine shed before the time of departure of his train or taking other duty.

The replies received by us do not enable us to establish any complete comparison of the rules in force for calculating the period of actual work.

In the French regulations « actual work » is taken as being the whole time during which employees have to remain on their engine or train, or have a given piece of work to do in a station, depot or workshop.

The period is taken as running from the moment when a driver (for example) joins his depot to the moment when he leaves it.

On certain *French railways*, however, and in particular on the *Northern Railway*, the service of a member of a train staff begins from the moment when be signs on at the office, and, where the distance between the office and this train exceeds 400 m. (440 yards), he is granted a supplementary allowance (5 minutes per 400 m. or fraction of 400 m.) which is added to the allowance before departure or after arrival to which reference will be made later.

On the *Danish State Railways* time spent in walking counts for one-half in calculating the period of actual work.

Allowances before departure and after arrival.

The periods allowed for the operations which employees may have to perform before departure or after arrival naturally vary according to the nature of such operations.

We give below several examples concerning :

A) staff of the Locomotive Department;
B) train staffs.

A) *Staff of the locomotive department.*

On the *large French railways* the allowances for preparing or for stabling an engine depend on the type of engine and the conditions under which the operations are performed.

Thus, on the *Northern Railway of France* the time allowance for drivers and firemen is as follows :

1° Before departure of the train :

a) If the preparation is entirely done by the engine crew : from 30 minutes to 1 hour 15 minutes, according to the type of engine;

b) If the preparation is entirely done by the personnel of the depot : a fixed period of 10 minutes.

2° After arrival of the train :

a) If the whole of the work in connection with stabling the engine is done by the engine crew : 20 to 30 minutes according as the crew does or does not belong to the depot where the engine is stabled;

b) If the engine crew is replaced on arrival : 10 to 15 minutes according as the crew does or does not belong to the depot where the engine is stabled.

The *Prince Henri Railway* allows its engine crews :

60 minutes before departure of the first train of the day;

30 minutes after the arrival of the last train of the day.

In *Denmark* engine crews are allowed 20 to 75 minutes for preparing or stabling their engines, the actual time depending on the type of engine.

In *Sweden* the following are the time allowances :

—	Large engines.	Small engines.	Shunting engines.
Drivers	Departure . . . 1 h. 15 m. Arrival. . . . 30 minutes.	45 minutes. 15 —	25 minutes.
Firemen.	Departure . . . 1 h. 30 m. Arrival. . . . . 30 minutes.	1 hour. 15 minutes.	40 —

In *Roumania,* for all trains :

Drivers, 1 hour; firemen, 1 h. 30 m.

In *Jugoslavia* :

Before departure : drivers, 1 hour; firemen, 30 minutes.
After arrival : nil.

In *Czechoslovakia,* for drivers and firemen :

Before departure : 1 hour. (If the work is done by the engine crew. If the work is done by depot employees the allowance is only 20 minutes.)
After arrival : 1 hour. (Ditto.)

In *Japan,* for drivers and firemen :

Before departure : from 1 to 2 hours.
After arrival : from 30 minutes to 1 hour.

The total time allowed, before departure and after arrival, being fixed at :

— 2 1/2 hours (3 hours in exceptional cases) for main line trains and busy services;
— 2 hours, as a maximum, for branch line trains and ordinary services;
— 1 1/2 hours, as a maximum, for very easy services;
— half an hour, as a maximum, for changing trains.

On the *South Manchuria Railway,* for drivers and firemen :

Before departure : 1 hour.
After arrival : 30 minutes.

B) *Train staffs.*

On the *large French railways* the time allowed varies according to the nature of the trains.

Thus, on the *Northern Railway of France,* train staffs are allowed the following periods for inspecting trains :

— passenger trains : 20 minutes before departure and 15 minutes on arrival;
— parcels and goods trains : 30 minutes before departure and 30 minutes on arrival.

In *Luxembourg* the periods are uniformly 20 minutes before departure and 10 minutes on arrival.

In *Denmark* they are generally from 20 to 30 minutes before departure and 15 minutes on arrival.

The same applies to *Greece.*

In *Sweden* the following are the allowances :

— for suburban trains, 15 minutes before departure and 15 minutes on arrival;

— for other trains, 30 minutes and 15 minutes respectively.

In *Roumania* :

— for passenger trains, 1 hour before departure and 30 minutes on arrival;

— for goods trains, 1 1/2 hours and 1 hour respectively.

On the *South Manchuria Railway* and the *Jugoslavian Railways* :

— for all trains, 30 minutes before departure.

In *Czechoslovakia* the regulations provide for the following time allowances :

—	Main lines.		Secondary lines.	
	Departure.	Arrival.	Departure.	Arrival.
Head guards.	60 minutes.	15 minutes.	30 minutes.	Nil.
Guards.	30 —	15 —	30 —	Nil.

In *Japan :*

— for passenger trains, mixed trains and coal trains, half-an-hour before departure and half-an-hour on arrival.

— goods trains of various kinds, 1 hour and half-an-hour respectively.

Waiting periods of personnel.

On the *large French railways,* when the interval between the arrival of a train which brings an employee to a certain locality and the time of departure of the train by which the employee leaves such locality, does not exceed 1 1/2 hours, this interval counts entirely as work.

The same is the case in *Greece.*

On the *Dutch Railways* only waiting periods which occur away from the employee's place of residence are counted as work.

On the *Belgian State Railways* any intervals which occur at the centre where an employee lives are deducted from the period of actual work.

Intervals occurring away from the place of residence count as actual work, unless they are equal to or exceed 8 hours in duration, in which case they are considered as daily rest periods.

If such intervals, however, are less than 8 hours but more than 2 hours in duration, 2 hours are deducted in calculating the period of actual work and the length of the working day.

In *Denmark* the interval between two trains (as described above) count as work if, when occurring away from the employee's place of residence, it does not exceed 1 1/2 hours in the case of drivers and firemen, or 1 hour in the case of train staffs. For intervals occurring at the place of residence the same rule applies when the interval is not longer than 30 minutes.

In *Norway* intervals of less than 1 hour are counted as actual work.

In *Sweden*, in suburban services, intervals of less than 30 minutes are counted as actual work. If between 31 and 60 minutes they count for 30 minutes of actual work. Beyond this they count for a quarter of the time.

In *Czechoslovakia* the interval between the arrival and departure of any one train counts as actual work. The interval between two different trains, even when these trains are worked by the same staff, is considered as a rest period.

On the *Polish Railways* intervals between trains are not considered as work if the employee is not obliged to remain at the place of work. If he is unable to leave the place of work, such intervals count for only a portion of their actual time in calculating the period of actual work.

In *Japan* waiting periods not exceed ing 4 hours in duration (for drivers and firemen) and 3 hours (for train staffs) are counted as actual work.

Long distance trains.

In view of the long periods of inaction involved in long distance journeys, the regulations formerly in force in certain countries provided for a reduction in calculating the period of actual work of train staffs accompanying long distance non-stop trains. This deduction was eventually abolished under French regulations.

Standing by, at depot or at home.

The French regulations make a distinction between periods of so-called « réserve-secours », « réserve à disposition » and « disponibilité à domicile ».

In the case of *drivers and firemen*, any period of « réserve-secours » (that is to say, any period during which the employee must remain at his depot, although not actually working) is, after deduction where necessary of the time required for preparation of a reserve engine, counted as to one-third of its duration as actual work.

In the case of *train staffs*, the first three hours count for one-third of their length if the employee leaves the depot during the course of the waiting period, or for their whole length if he remains at the depot for the whole time.

In the case of both engine crews and train staffs, periods of « réserve à disposition », *i. e.*, periods during which such employees can be given various kinds of work at the depot or station, count for the whole length in calculating the total period of actual work.

The period of « disponibilité à domicile », during which employees must remain at their homes in case they are called upon, counts for a quarter after the first four hours; the first four hours are not taken into account.

The regulations in force in other countries are generally on similar lines. For example, unoccupied reserve periods at depot count in *Sweden* for one-half their length, in *Norway* and in *Greece* for one-quarter, and in *Denmark* for two-thirds. On the other hand, in *Belgium, Luxemburg, Holland* and *Japan* such periods count wholly as actual work.

Periods spent in reserve at domicile count for one-quarter their length in *Norway* and *Sweden*, and for one-third in *Denmark* and *Poland*.

Allowance for delays when calculating period of actual work.

As a rule the calculation of the period of actual work is based on the actual time of arrival of a train; but in certain countries, and in particular on the *Belgian*

Light Railways and on the *Swedish, Danish, Roumanian* and *Czechoslovakian* Railways the time of arrival is only taken into consideration in cases of delays of more than 30 minutes.

In the case of shorter delays, the ordinary scheduled time of arrival is taken as the basis.

Special regulations relating to drivers and firemen of shunting engines.

The rules quoted above only apply to personnel engaged on main line traffic services.

Drivers and firemen attached to the shunting service in stations and depots are generally, as is the case on the *large French Railways*, required to be present at the place of work for 8 hours daily, whether such period is continuous or not.

Output.

It would have been particularly interesting to be able to give statistical data with regard to the utilisation of personnel resulting from the various sets of regulations referred to.

The information at our disposal, however, only enables us to give particulars in the case of *France* and *Japan*.

For the whole of the *large French railways*, and for the year 1923 :

1° the number of train-kilometres (train-miles) amounted to	392 524 910 (243 907 914)
2° the number of drivers and firemen on main line duties was.	31 382
3° the average number of train-kilometres (train-miles) per employee of the Locomotive Department (1 : 2) was	12 507 (7 772)
4° the number of train staff employees was	37 149
5° the average number of train-kilometres (train-miles) per train employees per annum was	10 566 (6 566)

The hours worked by the engine crews and train staffs, based on a system of rotation, varies on different railways, but is on the average about 7 hours 20 minutes for drivers and firemen and 7 hours 30 minutes for train staffs, including unoccupied time spent in returning to depots, intervals of waiting, time allowances on departure and on arrival for preparation or stabling of engines, inspection of trains, etc.

The hours of staff not working on a system of rotation are generally less. The difference in the length of the working day, as between the two classes, amounts to 40 minutes in the case of certain railways.

From statistics relating to the Northern Railway of France it appears that the average daily length of journeys is 95 km. (59 miles) for drivers and firemen and 106 km. (66 miles) for train staffs.

On the *Japanese State Railways* the average daily distances done by the engine crews is 55 miles, and 58 miles in the case of train staffs.

STATIONARY STAFF.

STATIONS AND DEPOTS.

Regulations in force in the various countries generally cover the following points :

1° Basic period for calculating average daily work;

2° Distinction between actual work and attendance at place of work;

3° Maximum daily duration of actual work;

4° Limits of working day;

5° Intervals;

6° Length and distribution of periodical rests;

7° Organisation of work in shifts;

8° Special services, *e. g.*

a) Work of substitute staff;

b) Work of pointsmen.

1° Basic period for calculating average daily work.

In certain regulations, and in particular in those of the *Belgian Light Railways*, the *Tunisian Railways*, the *Reims Suburban Railways* and the *Jugoslavian Railways*, the 8 hours' limit for actual work applies uniformly to every day of service, and it is not permissible in normal circumstances to exceed this limit.

On other railways (*Norwegian Railways*, *Indre and Deux Sèvres Tramways*, and *Railways of the Tarn Department*) the 8 hours' limit is calculated on the average for the week.

As in the case of their mobile staff, the *Polish Railways* limit the work of their stationary staff to 46 hours per week.

In *Holland* the limitation is fixed for a period of fourteen consecutive days at 90, 96, 100, 102 or 114 hours, according to the category of the personnel.

In *Sweden* and *Denmark* the average of 8 hours is calculated over a period of one month, and employees may not work more than 208 hours per twenty-six days. In *Denmark*, however, in the case of depot staffs paid by the hour, the limit is fixed at 48 hours per week.

The month is also taken as the basic period in calculating the average working day in the case of the *Nora Railways* (*Sweden*), where the regulations provide, to allow for the seasons, a monthly average of 234 hours for the summer months (April to September) and 182 hours for the winter months (October to March).

On the *Czechoslovakian State Railways* the same limits apply to all employees, *viz.* 48 hours per week. For employees engaged in alternate service the limit is 192 hours per period of four consecutive weeks.

Under other regulations the daily, weekly or monthly limits are found either in combination or in superposition.

For example, on the *Prince Henri Railways* the working period is limited to 8 hours per day or 48 hours per week or 192 hours per period of four consecutive weeks, according to the necessities of the service.

On the *Belgian State Railways* the period of actual work is limited to 8 hours per day.

In services, however, where the work is effected by successive gangs, this 8 hours' limit may be increased to 10 hours provided the *average* duration of actual work, calculated over a period of not less than three weeks, does not exceed 8 hours per day, or 48 hours per week.

On the *large French railways* (1) the regulations based on the decree of the 14 September 1922 stipulated that the average of 8 hours' actual work must be calculated over the whole year, employees being required to do 2 504 hours' actual work between the 1 January and the 31 December (or an average of 8 hours per day for 313 working days).

In the new regulations based on the decree of the 16 January 1925, the annual limit is replaced by a narrower limit. As from the 25 February 1925 the *large French railways* have to draw up a scheme of work for the stationary staff, choosing one of the two following limits: either 8 hours per day, or an average of 8 hours per day over a period of not more than ten consecutive days, it only being permissible to increase this limit of ten days to forty-five days in certain exceptional cases, such as on account of seasonal variations in traffic and with the special authorisation of the Minister of Public Works.

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(1) The present report having been drawn up at the beginning of 1925, at the moment when a modification occurred in the regulations relating to the work of stationary employees, we have thought it desirable to make a brief comparison between the regime instituted by the decree of the 14 September 1922, and that instituted by the decree of the 16 January 1925, the latter of which took effect from the 25 February 1925.

2° Distribution between actual work and attendance at place of work.

In certain countries (*Holland, Luxemburg* and *Greece*) the regulations do not, as regards the staff of stations and depots, make the distinction laid down by the Washington Convention actual work and light or intermittent work, that is to say, the period of daily attendance under these regulations is the same whether it is a case of an employee working continnuously or of one whose work is broken by intervals of inaction, such employee, however, being required to remain on the spot the whole time in case he is needed.

In *Japan*, where at present no distinction is made between attendance and work, the question is being considered with a view to formulating definite regulations.

The regulations of a number of railways differentiate clearly between actual continuous work and intermittent work. Thus, on the *Belgian State Railways* employees whose work is of a distinctly intermittent character may put in 12 hours daily if they inhabit a railway dwelling, and 10 hours in the opposite case provided, of course, that the actual work executed during this period of 12 or 10 hours does not exceed the total of 8 hours.

The following employees are considered as executing work of a distinctly intermittent character (Royal Decree of the 21 March 1923) :

a) *Workmen, viz.:*

Turntable attendants at easy posts.

Assistant turntable attendants at easy posts.

Doorkeepers, messengers and junior messengers.

Ticketcollectors and waiting room attendants at small stations.

Workmen at 4th class stations and halts.

Station cleaners.

Messengers.

Male and female booking clerks at roadside stations.

b) *Lower grade staff, viz. :*

The staff at roadside stations and the subordinate staff of 4th class stations.

In *Sweden*, in the case of certain classes of employees engaged in light work, the regulations allow of 234 or 260 hours' work per month, instead of 208 hours.

In *Norway* the above also applies to guards' work (1 1/4 hours' attendance equals 1 hour actual work).

In *Czechoslovakia* the daily period of service for employees at small stations may be prolonged, provided the total amount of actual work does not exceed 6 hours per day.

In *Denmark*, in cases where work is really intermittent, the monthly limit of 208 hours per month is replaced by a limit of 234 hours (average of 9 hours per day) or of 260 hours (average of 10 hours per day), according to the nature of the work.

On the *Polish State Railways* the working period varies also according to the nature of the work; employees engaged in continuous work put in 46 hours' attendance per week (coefficient 1); employees engaged in intermittent work put in the following hours on the basis of the coefficient of intermission :

56 hours per week (coefficient : 5/6) ;
70 hours per week (coefficient : 2/3) ;
91 hours per week (coefficient : 1/2) ;
138 hours per week (coefficient : 1/3).

In *France*, on the « *Département* » *Railways* and *Tramways of the Indre*, the period of actual work corresponds to the period of attendance during which the employee is at the dispoal of the public. In certain small stations, however, the employee, although attending during the whole of the time the station is open, is only paid for 8 hours.

The same applies to the *Ain Tramways*.

On the « *Département* » *railways of the Midi* attendance is counted as actual work to the extent half its duration.

On the *Tunisian Railways* stations are divided into three categories according to their importance; in the large stations the whole period of attendance counts as actual work.

In the middle and smaller sized stations half the period of attendance counts as actual work, although this only applies if the period does not exceed 4 hours.

On the *large French railways* the decree of the 14 September 1922 provided that in the case of employees engaged in intermittent work, account should be taken, when fixing the period of attendance, of the nature and importance of the work performed. The daily period of attendance was, however, limited to 12 hours in the case of messengers, clerks, ambulance men, employees engaged in the issue of tickets, payments, receipt of cash, reimbursements, employees whose principal work is in connection with trains within the station, employees engaged in the work of ticket offices which are only open to the public intermittently, telephone and telegraph staff, employees at 5th and 6th class stations and halts (1), workmen in electricity sub-stations, employees in charge of hydraulic installations, employees in charge of generating plant, overhead travellers, or bridge turntables, employees specially attached to signalling or pointsmen's posts where, during the daily period of work the average hourly number of trains, calculated over a period of one month, is less than 4, employees engaged in work inside carriages, employees in charge of stationary pumping engines and reserve foremen.

The decree of the 16 January 1925, by modifying the formula for calculating periods of inaction, appreciably reduced the number of station employees in whose case the period of attendance may be increased to 12 hours per day.

Under the regulations based on the decree of the 14 September 1922, an employee at a small station could put in 12 hours' attendance provided that this period included 4 hours' inaction, so that in fact the actual working period amounted to 8 hours.

Under the new regulations the periods of inaction count as actual work up to one-quarter of their duration; consequently the period of attendance can only be extended beyond 8 hours by a period equal to 3/4 of the sum of the periods of inaction recorded for the employee concerned.

Under this rule, the maximum duration of the period of attendance, that is to say 12 hours, can only be attained by employees whose service allows of 5 hours 20 minutes inaction, which in effect means the reduction of the actual working period to 6 hours 40 minutes.

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(1) In practice the 12 hour limit applies to shunting yards, stations and halts with an average number of employees not exceeding 15.

3° Maximum daily duration of actual work.

We have seen above that under the regulations of certain companies the average of 8 hours' actual work is calculated over a certain period (week, month, year), by which arrangement it is possible, on certain days, to exceed the average of 8 hours, thus making it possible to vary the hours of the employees to meet the exigencies of traffic.

On certain railways, as for example the *Roumania and Serbian Railways*, the daily duration of work is only limited by the obligation to adhere to the daily average of 8 hours' actual work.

In *Denmark* the daily limit is 15 hours.

In *Sweden* the limit is generally 11 hours.

On the *Belgian State Railways*, as well as in *Holland, Norway, Greece, Czechoslovakia* and *Luxemburg*, the limit descends to 10 hours. This minimum is also adopted by the French regulations under normal circumstances (¹).

In *Poland* the maximum period is 12 hours (¹).

4° Limits of working day.

The limits of the working day, that is to say the time between the moment when the employeee arrives at the place of work and the moment when he leaves it finally, may vary according to the nature of the work, the size of the centre, and the housing facilities provided for the employees.

Under the *French regulations* which came into force in 1922 the limits were as much as 15 hours for employees who received free housing accommodation on the spot or within a radius of 1 km. (0.6 mile) of their work centre, and 14 hours for other employees.

In the case of small stations and halts, these limits, made it possible to obtain a satisfactory output in the case of employees engaged in the running of trains throughout the whole period a station was open. In certain branches of the service (fast and slow train goods and parcels office) these limits also made it possible to have available the maximum number of employees at the busiest moments of the day, and in particular in the morning and evening, the quieter hours of the day needing a less numerous staff.

By the decree of the 16 January 1925 the length of the working day was reduced to 12 hours; it is only in certain cases, determined by a complex procedure described later (which brings into account the railway, the staff or its delegates and the Control Service), that this limit can be extended to 13 hours at stations and halts (that is to say in centres the staff of which does not as rule exceed 3 employees) for staff whose work is directly connected with the train service or dependent upon the conditions regulating the hours during which such stations and halts are open to the public.

In exceptional cases, at these stations and halts, the limit may be increased to 14 hours in the case of employees for whom a dwelling is provided, in cases where the exigencies of the train service would otherwise require the services of an additional employee between the 13th and 14th hour. The limit can only be extended to 15 hours in the case of employees for whom free lodging accommodation is provided on the spot or in the immediate vicinity of the place of work.

Further, if as the result of exceptional circumstances an employee whose normal limit is 12 hours (at large centres) or 13 hours (small stations and halts) is re-

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(¹) This limitation does not, of course, apply to employees whose duties are intermittent; in such cases the maximum is 12 hours in France and 16 hours in Poland.

quired to put in 14 hours' attendance, such working day must be followed by a rest of at least 10 hours after which the employee resumes his normal hours as fixed by the regulations.

On the *Rheims Suburban Railways* the normal limit is 12 hours (employees without dwellings) and 14 hours (employees with dwellings).

On the *North-Eastern Light Railways* (*France*) the limit is 15 hours.

On the « *Département* » *Railways of France* the minimum night rest varies between 7 and 12 hours (for employees without dwellings) and between 8 and 12 hours (for employees without dwellings), according to the particular lines.

With the exception of *Czechoslovakia* and *Roumania*, where it appears that the duration of the rest separating two consecutive periods of work must not be less than 12 hours for employees with dwellings as well as for employees without dwellings, the regulations of the majority of railways fix the minimum length of this rest at 12 hours.

Thus, on the *Belgian State Railways*, the length of the daily rest may be as low as 8 hours in the case of all employees. The same is the case in *Sweden* and *Poland*.

In *Norway* the length of the daily rest must be at least 9 hours in times of normal service, but it may be reduced to 6 hours if the exigencies of the service require it, and even to 4 hours, subject to the consent of the employees. In *Greece* the minimum length of the daily rest is 8 hours for employees with dwellings and 9 hours for others.

On the *Prince Henri Railways* employees with dwellings are entitled to a minimum rest of 8 hours, and other employees to a minimum of 10 hours. In *Denmark* two consecutive periods of work must be separated by a rest of 9 consecutive hours, which may be reduced to 8 hours provided the employees agree.

5° Intervals.

The organisation of the service, or the intervals necessary for the taking of meals, obliges the majority of employees (in particular those who are not engaged on regular duties with two or three regular breaks) to carry out their daily work in several sections.

The intervals, when they are of very short duration, are allowed to the employee to enable him to take a meal at the place of work, either with or without interruption of work.

In the regulations of most railways the number of breaks is not limited.

As a general rule, however, the number does not exceed 2 (*Denmark*, *France*, under normal circumstances) (*Luxemburg*) or 3 (*France*, under exceptional circumstances) according to the size of the particular centre and the length of the working day.

The length of these intervals is not as a rule fixed by the regulations, although there are exceptions to this in certain countries. In *France*, for example, the minimum length of the break is 1 1/2 hours, if there is only one break. If there are several, the longest must be of at least 1 1/2 hours and the others 1 hour.

In *Roumania* when there are two breaks, they must each be of at least half-an-hour's duration. When there are three, the longest must be at least 1 1/2 hours and the others 10 minutes each.

On the *Jugoslavian Railways* the minimum length of intervals for meals is 2 hours.

In *Luxemburg* the minimum length of intervals for meals is half-an-hour for station staff and 1 hour for locomotive and train staff.

6° Length and distribution of periodical rests.

a) *Countries in which the weekly rest is adopted.*

Under French regulations the staff of stations and depots are entitled to 52 rest days. The normal interval between these rests is 6 days, which may on occasion be increased to 10, or, in very exceptional circumstances, to 14 days.

The normal minimum length of these rests is 24 hours. To this period there is generally added the daily rest period immediately preceding or following the main periodical rest.

In branches of the service where work partially ceases on Sundays and public holidays, the periodical rests are granted for preference on such occasions, by whole days or half-days, the number of the half-days, however, not being greater than the number of whole days.

On the *Belgian State Railways* station and depot employees receive 59 days' rest per annum, taken as far as possible on Sundays and public holidays.

The length of these rests is not less than 32 hours, and must be at least 34 hours whenever the exigencies of the service permit.

When two rests are combined (for example, when the exigencies of the service have necessitated the postponement of the first rest), their minimum total duration is 56 or 58 hours.

The rests must extend over two consecutive nights, beginning before 10.0 p. m. and ending not earlier than 6.0 a. m.

Rests may also be taken in half-days.

In *Sweden* rests are granted as far as possible on Sundays and public holidays. If the interests of the service require the presence of employees on Sundays or holidays, such employees must be given one Sunday out of two, or in case this is impossible, the Sunday rest must be replaced by a week-day rest.

The length of the rests must be not less than 24 hours. It may be as much as 30 or even 36 hours, according to the interval between the rests.

In *Norway* employees are given a weekly rest of about 30 hours, which may be reduced to 20 hours if necessary in the interests of the service, or to less than 20 hours if the consent of the employees is obtained.

In *Denmark* the 52 rests per annum must be of at least 36 hours' duration each (or 33 hours in exceptional cases).

On the *Prince Henri Railways* employees must be given 1976 hours' rest per annum, at the rate of 38 hours per rest. The maximum interval between two rests is 12 days, but in practice the interval is from 6 to 9 days, and the minimum length of rests is 32 hours.

In *Roumania* employees at depots and office staff receive a half-day rest on Sundays and public holidays.

In *Czechoslovakia* the law guarantees to employees engaged in continuous work a weekly rest of at least 23 hours' duration; in practice this is increased to 36 hours.

Employees working alternately in day and night shifts are also given rest periods of varying length, but one of the rests must be of at least 32 hours' duration in every 3 weeks.

b) *Countries which do not adopt the weekly rest system.*

In *Greece* depot staffs are granted one long rest per month. No minimum is fixed for the duration of this rest.

Station employees receive one long rest per month. This rest must comprise the whole period between two consecutive night's rest.

On the *Jugoslavian Railways* the main

periodical rests are regulated as follows :

for an employee with 5 years' service : 15 days,

for an employee with 15 year's service : 25 days,

for an employee with more than 15 years' service : 45 days.

In *Japan* the minimum number of rests is 2 per month for employees not working in alternate shifts, and the maximum number is 4.

The number and the length of the rests varies greatly according to the nature of the work, and the administration is at present considering the possibility of adopting regulations to deal with this question.

7° Organisation of work in shifts.

Frequently the length of the working day, or the amount of work which has to be performed, makes it necessary to employ 2, and even 3, employees in turn, on the same day for the same duties.

On the *large French railways*, in cases where work is organised in two or three shifts, and all the employees are subject to the same conditions as regards alternation of working periods and rest periods; or, alternatively, when the shifts are so arranged that each shift keeps constantly to the same hours; it must be arranged that no employee shall be compelled to work for more than eight nights consecutively (decree of the 16 January 1925) (1). Whatever be the duration of the round of shifts, the total number of night shifts may not, in the case of any employee, exceed half or one-third the number of days comprised within the following round, whether the work is arranged in two or in three shifts.

Night shifts are taken as those which comprise the whole of the period between 1.0 a. m. and 3.0 a. m.

The commencing and finishing hour of each of the two or three shifts are not stipulated in the regulations but in practice, where there are two shifts, they generally end at about 6.0 a. m. and 6.0 p. m., or, where there are three shifts, at about 6.0 a. m., 2.0 p. m. and 10.0 p. m.

On the *Belgian State Railways* alternating services are generally arranged in three shifts, from 6.0 a. m. to 2.0 p. m., from 2.0 p. m. to 10.0 p. m. and from 10.0 p. m. to 6.0 a. m.

Employees work alternatively in each of the three periods over a period of from three or six weeks, and their work is subject to the general regulations. Their periodical rest must be of at least 32 hours duration.

In *Japan* and on the *South Manchuria Railway* the division of the working day into three shifts is quite exceptional. In general, work is organised in the following manner :

Work during 24 hours, followed by a 24 hours' rest. The working day is devided by a 2 or 3 hours' rest about midday. Not counting this 24 hours' rest, the average length of the working day, including the short intervals for meals and rest, slightly exceeds 10 hours.

The above arrangement may also exist side by side with an ordinary system of day-work.

The replies to the list of questions furnished by other railways do not enable us to study the organisation of alternating service on those railways.

The only details which we can give relate to definition of « night work », and to the maximum number of consecutive nights' service.

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(1) Under the former regime (decree of 14th Sept. 1922) this number might be increased to 10 consecutive night shifts, compensated for, at the desire of the employee, by longer periodical rest periods.

On the *Prince Henri Railways* the maximum number of consecutive nights is 7.

On the *Polish State Railways* night work is taken to comprise all work which includes at least two hours between 9.0 p. m. and 5.0 a. m. Night work is subject to a maximum of three consecutive nights, or, in exceptional cases, six nights. The total number of hours of night work within a period of two weeks must not exceed the number of hours of day work during the same period.

In *Roumania* night work is work between 6.0 p. m. and 6.0 a. m.

In *Czechoslovakia* night work covers the time between 8.0 p. m. and 5.0 a. m. The number of consecutive nights must not exceed 2 as a general rule, or 3 in exceptional circumstances in the case of certain categories of employees.

In *Greece* night work is work done between 1.0 p. m. and 4.0 a. m. The maximum number of nights is not fixed for depot staffs; it is 14 for station staffs.

On the *Swedish Railways* work which includes two hours between 11.0 p. m. and 5.0 a. m. is defined as night work. With the exception of night-watchmen and employees who change over every two weeks, night work must not be required for more than one night out of three.

8o Special services.

a) *Temporary staff.*

In a general way the work of temporary staff is subject to the same regulations as the work of the staff they replace.

When this temporary staff is obliged to travel to the place of work, the journey counts in calculating the period of actual work.

On the *Belgian State Railways*, temporary employees specially employed to take the place of men on leave, resting, or ill, must live as near as possible to the centre of the localities in which they will be employed. The journeys by railway to and from the place of work count wholly in calculating the period of actual work.

Under the regulations of the *large French railways* (decree of 16 January 1925) the working day of a temporary employee must not exceed 13 hours, even if the man he replaces worked 14 or 15 hours, as happens in the case of small stations and halts.

Consequently, it frequently happens that the temporary employee cannot carry out the whole of the duties of the man he replaces.

In calculating the total period of actual work (*i. e.*, in calculating the 8 hour average over a given period) :

— journeys on engines or relief trains count for their whole length;

— the following count for half their length :

a) journeys by train for the purpose of going to or from the place of work (*i. e.*, when the employee is not working during such journey);

b) the time between the arrival of the employee at the place of work and the time at which he actually begins work; and the time between the moment at which he ceases work and his departure from the place of work.

b) *Pointsmen.*

In the absence of information from other countries we shall have to content ourselves with merely indicating that on the *large French railways* the working period of pointsmen, under the « régime » abolished at the beginning of 1925, was dependent upon the number of trains passing during the period of work; if the number of such trains was less than four per hour, the length of service of each employee might be increased to 12 hours, which made it possible to work the post with only two employees, one by day and one by night.

If the number of trains exceeded four per hour, the working period might vary between 8 hours and 12 hours, according to the density of the traffic and the amount of accessory work to be done by the employee (attention to permanent way apparatus, signals, telephone, etc.).

Under the « régime » instituted by the decree of the 16 January 1925, the period of attendance of pointsmen at their place of work is calculated to include the periods of inaction provided for in the formula described above in the case of other station employees; the period of attendance may be prolonged beyond 8 hours by a period equivalent to 3/4 of the total length of the periods of inaction recorded in the employee's working day.

PERMANENT WAY STAFF.

The permanent way staff may be divided into two main categories :

1° Employees engaged in maintenance work;

2° Employees engaged in inspection or supervision, including gatekeepers.

Employees engaged in maintenance of the permanent way.

As a general rule the permanent way staff is subject to the same regulations as the stationary staff at stations and depots.

In view, however, of the special conditions which apply to the work of these employees, certain modifications occur, particularly as regards the distribution of work between the different seasons.

It is in fact impossible for employees working on the permanent way to do the same amount of work constantly at all seasons of the year, firstly because of the variation in the length of days and nights, and secondly because of weather conditions.

On the *Czechoslovakian Railways,* as on the *Swedish State Railways,* the « English week » is adopted for permanent way maintenance staff, that is to say such employees work 8 1/2 hours per day except Saturday, when they only work for 5 1/2 hours. They do not work on Saturday afternoon or Sunday.

The working day is divided by intervals just sufficiently long to enable employees to take a meal at the place of work.

In *Denmark* work is distributed as follows :

7 hours per day in December and January;

9 hours per day from the 15 March to the 15 May;

8 hours per day for the rest of the year.

In *Roumania* employees work two hours longer per day in the summer season 1 March to 1 November) than in the winter season (1 November to 1 March).

On the *Swedish State Railways* the average period of work is calculated at the rate of 208 hours per month; this average is observed by working 195 hours per month from October to March, and 221 hours per month during the other months of the year.

In *Poland,* where permanent way personnel work for 8 hours per day without a break on all working days of the year, the possibility is being considered of increasing the length of the working day to 10 hours during the summer months, and shortening it to 6 hours during the winter months.

In *Japan* the working hours of the permanent way staff vary according to the season : 9 hours per day from November to February; 10 hours from March to April; 11 hours from May to August; 10 hours from September to October; giving, for the whole year, a daily average of 10 hours.

Work below ground never exceeds 10 hours per day.

There are three breaks in the working day, 2 of 15 minutes each, morning and evening, and one of at least half-an-hour for the midday meal.

In *Greece* the length of the working day is one hour more in summer (March to October) than in winter (November to February) (10 hours instead of 9).

On the *South Manchuria Railway* the permanent way maintenance staff also work for an average of 8 hours per day throughout the year, with a longer day in summer than in winter.

In *Luxemburg* and *Czechoslovakia* the length of the working day is uniformly 8 hours throughout the year.

In *Holland* employees engaged in the maintenance of the permanent way, or work in connection therewith, must not ordinarily be required to work more than 10 hours on any one day, or more than 102 hours in any period of two consecutive weeks.

If, however, between the months of November and February, the number of hours' service effected in the course of each period of two weeks has been below 100, it is permissible during the other months of the year to exceed the maximum of 100 hours per fortnight, without, however, in any given fortnight, exceeding the maximum of 114 hours, and without exceeding the general average for the whole year of 102 hours per fortnight.

On the *Belgian State Railways* these employees work 8 hours per day the whole year round. The working hours are from 7 a. m. to 4.0 p. m. in summer, and from 7.30 a. m. to 4.30 p. m. in winter, with an interval of one hour for the midday meal.

On the *large French Railways*, prior to the publication of the decree of 16 January 1925, the average of 8 hours per day was calculated over the whole year, so that it was possible to adopt all kinds of rearrangements of hours to make up, during periods or days of fine weather for hours of work lost during the bad season or on days when the weather was bad.

Under the new « régime » (decree of the 16 January 1925), the work of employees engaged on maintenance of the permanent way, the maintenance of electric installations and signals and other technical equipment of the line, is fixed so as not to exceed an average of 8 hours per day over successive periods of not more than 90 days each; in no case, however, must the period of actual work on any one day exceed 10 hours.

It is, however, permissible to increase the average of 8 hours to 9 hours during a period of three months, provided the extra hours are allowed for during three other months of the year.

The working day is generally broken by an interval of at least 1 hour for a meal.

The total length of the working day cannot, under any circumstances, exceed 13 hours.

While the regulations in force in certain countries (*Denmark* and *Holland*) do not count as actual work the time spent in walking along the line to and from the place of work, the French regulations allow 12 minutes per kilometre (19 min. per mile) in excess of 5 kilometres

(3 miles) per day (outward and return journey included).

In *Japan* working hours count from the moment the employee signs on at the beginning of the day to the moment when he signs off at the end. Journeys to and from the place of work are therefore counted in calculating the length of the working day.

On the *Czechoslovakian Railways* journeys on foot are not counted except from the spot at which the gang assembles, any journey necessary to reach this spot not being counted.

Employees engaged in inspection or supervision, including gatekeepers.

On the *large French railways* employees engaged in the supervision of the permanent way are required, as in the case of other employees, to do 8 hours' actual work on an average per day. In the case of those whose work is of an intermittent character, the period of attendance at the place of work may be extended beyond 8 hours though the period of attendance with a maximum limit of 12 hours, except in the case of gatekeepers who are allowed to leave their gates or watchbox and to return to the gatehouse, and except also in the case of employees who live on the spot and who, for a period of at least 6 hours are engaged exclusively on gate work. For these two classes of employees, the period of daily attendance at the place of work may be increased to 15 hours.

When a woman gatekeeper does the day-work at a level crossing, the night work may be done by a member of her family who is employed by the railway in other work than that of a gatekeeper, provided such employee is not called upon to get up more than 60 times a month between 9.0 p. m. and 5.0 a. m.

Each opening of the gates by such employee between the above hours is taken as equivalent to 20 minutes excess work, entitling him to a corresponding reduction of the length of the normal working day at his normal place of work on the railway.

On the *Belgian State Railways* the maximum daily period of attendance is 12 hours, but only at very easy posts, when the gatekeepers are provided with a dwelling on the spot. Gatekeepers at similar posts, but not provided with dwellings, may be required to work for 10 hours, the total period, including proceeding to and from the place of work, not to exceed 12 hours. At busy posts the working period is 8 hours, with a maximum, including time spent in going to and from the place of work, of 12 hours.

When the employees are not housed, the period of attendance must not exceed 8 hours, within maximum limits (as described above) of 12 hours.

Night work is always done by male employees, for in *Belgium* the law forbids the employment of women, or children under 18 years of age, in night work.

In *Holland* in the case of staff exclusively or principally engaged in the supervision of the permanent way, the period of attendance must not exceed 12 hours for any one day; or, for a period of fourteen consecutive days, 144 hours if the employee lives near to the place of work, and 132 hours in the opposite case.

In *Luxemburg* the work at level crossings is permanently carried out by two employees, working 12 hours per day each. At the less busy posts a single employee may put in up to 16 hours of attendance daily.

In *Poland* the hours of service of gatekeepers are calculated according to the number of trains passing over the level-crossing, each train counting for a certain number of minutes of work, varying according to the kind of train.

In *Sweden* the hours of service of gatekeepers may not, as a general rule, exceed 12 hours. This period may, however, be increased to 16 hours in cases where this is in the interests of the service. Each train which passes counts for 20 minutes of actual work, the remainder of the period of attendance being counted as to 1/4 of its length as actual work.

In *Roumania* this class of employee is engaged on mixed service; for example, they do a round of inspection of the permanent way in the morning, rest in the afternoon (between 11.0 a. m. and 6.30 p. m.), and then at night act as gatekeeper at a level-crossing. If there are no gates in their district, they do their round in the morning, and work with a repair gang in the afternoon.

On the *Czechoslovakian State Railways* the service of employees engaged on permanent way supervision (gatekeepers, signalmen and block signalmen, etc.) is regulated according to the amount of actual work to be done in each case. When the period of actual work executed during the whole period of daily attendance does not exceed 6 hours, the employee may be required to attend for more than 8 hours.

In *Japan* level-crossings which require permanent attendance are kept by employees who work for 24 hours at a stretch and then rest for 24 hours.

WORKSHOP STAFF.

The organisation of work in railway workshops is more or less similar to that in ordinary industrial workshops. In principle, all employees work 8 hours per day (9 hours in *Japan* and *Greece*, 9 hours and 10 hours on the *South Manchuria Railway*) or 48 hours per week.

The regulations of certain railways (*Czechoslovakia, Poland, Denmark, Holland, Société des Transports en commun de la région parisienne*) adopt the « English week », *i. e.*, 8 1/2 hours per day on the first five days of the week, and 5 1/2 hours on Saturday (or other similar arrangement).

The period of attendance is generally divided into two sections, one in the morning and the other in the afternoon, by an interval for the midday meal. This interval varies from 40 minutes to 2 hours, according to the circumstances of time and place.

On the *Norwegian State Railways* the Saturday rest does not obtain, so that employees may do their 8 hours' work at a single attendance.

In certain cases the two sections (morning and afternoon) are divided by a short rest period, varying between 10 and 30 minutes according to circumstances, to enable the employees to take a meal.

Rest periods are generally taken on Sundays and public holidays, except in the case of gangs engaged in continuous night and day work, or in cases where workshops remain active on Sundays and public holidays.

As a rule calculation of the period of service, as defined above, begins from the moment of commencing and ends at the moment of ceasing actual work, that is to say, it does not include the time taken for meals, washing and changing uniform, and handing over of work from one gang to the next.

The regulations of certain companies, based on article VI of the Washington Convention, provide for a prolongation of the normal working day in the case of certain categories of preparatory or supplementary work which must necessarily be executed outside the limits fixed for the general work of the railway.

Thus, the French regulations provide for a prolongation of the working day in the following cases :

1° Work of employees engaged in connection with motive power, lighting, heating and lifting apparatus;

2° Work of employees engaged normally or exceptionally whenever the normal work of the railway is suspended, in the repair or cleaning of machinery, engines, or other plant which continuity of work prevents from being withdrawn from service otherwise than at such periods of stoppage;

3° Work of head and assistant gang-foremen or of specialist employees whose presence is indispensable for co-ordinating the work of two successive gangs;

4° Work of head and assistant gang-foremen in preparing for work to be executed by their sections;

5° Work of officials, foremen and specialist employees connected with experiments or tests for the improvement of existing apparatus or for the installation of new apparatus.

The length of the working day may not be increased by more than 1 hour in the case of assistant foremen, workmen and labourers, or by more than 2 hours in the case of head foremen or inspectors.

REGULATIONS APPLICABLE TO THE WHOLE OF THE STAFF.

After having examined the regulations relating to the work of the various classes of staff, it is necessary to note certain provisions applicable to all employees.

The following observations will bear upon the points :

1° Employees not subject to the regulations in force;

2° Permanent or occasional exceptions, and remuneration of overtime work. Obligation to execute the work allotted Conditions to which certain employees are subjected outside working hours;

3° Intervention of the personnel in questions concerning application of regulations relating to conditions of work;

4° Annual holidays.

Employees not subject to the ordinary regulations.

The Washington Convention, in article 2 (*a*), states that its provisions « are « not applicable to persons occupying an « inspectorial or administrative post or « a confidential position ».

In the absence of other information we will quote the interpretation lent to this clause by the French and Belgian regulations.

On the *large French railways* the public administration decree of the 16 January 1925 is not applicable :

« To employees at stations or depots of « a grade at least equal to that of assistant « stationmasters of large stations; employees of the permanent way maintenance service of a grade at least equal « to that of 2nd class 'district superintendents' or of officials carrying out « the duties of such a post; head guards, « electricians and employees of the locomotive Department of a grade at least « equal to that of assistant superintendent of a 3rd class depot; employees of « the regional and central services or central administrations, of a grade at least « equal to that of a 2nd class chief clerk; « employees connected with the surveying and purchase of ground; employees « in charge of stores, and employees engaged in various branches of reception, « supervision, control and inspection, « whose work is not normally subject to « any fixed service conditions. »

A decree of the Public Administration, not yet promulgated, will eventually fix the conditions under which the law of the 23 April 1919 regarding the 8 hour day will be applied to the above personnel.

On the *Belgian State Railways* the ordinary regulations do not apply to employees who, under the terms of the law of the 14 June 1921, « can be considered as occupying positions of confidence ». Such employees are :

Chief and superintendent of technical or administrative department;
Engineer;
Technical inspector;
Sectional superintendent;
Architect;
Chemist;
Inspector;
Divisional superintendent;
Chief clerk;
Controller;
Deputy chief clerk;
Stationmasters of all classes;
Building surveyor;
Running shed superintendent;
Works superintendent;
Chief cashier;
Cashier and accountant;
Auditor;
Superintendent of railway police;
Assistant superintendent of railway police;
Head guard;
Police official;
Workshop head foreman;
Workshop foreman, traffic foremen, signal department foreman, or permanent way foremen;
Foreman in charge of a small workshop, or engaged in the supervision or instruction of permanent way workmen;
Machinery instructor;
Locomotive inspector on traffic service or in charge of the work of a small engine shed;
Foreman platelayer;
Foreman superintendent in control of the work of supervision and instruction on the permanent way;
Works inspector;
Reception official;
Storekeeper, where the nature of his duties is similar to that of the duties of a head storekeeper;
Depot caretaker;
Examiner.

Exceptions.

Apart from the « permanent exceptions « which may be allowed in the case of « preparatory or supplementary work « which may be necessary outside the « limits laid down for the general work « of the undertaking » (1) the Washington Convention provides, in article 3, that the limit of 8 hours per day or 48 hours per week « may be exceeded in case of « accident, or in case of urgent work ne« cessary on engines or equipment, or in « cases of ‘ force majeure ’, but only to « the extent necessary to avoid serious « dislocation of the normal work of the « industry ».

Article 6 also provides that the regulations to be drawn up for each industry or profession shall fix the temporary exceptions which shall be « admissible in « the case of extraordinary pressure of « work ».

Finally, article 14 stipulates that « the « provisions of the Convention may be « suspended in any country in case of « war or of occurrences threatening na« tional security ».

These clauses are reproduced in the French regulations, which provide that modifications may be made in the normal conditions of work in the following cases:

1° Urgent work, the immediate execution of which is necessary in order to prevent accidents, to organise relief measures, or to repair the damage caused by accidents;

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(1) See p. 1768, above.

2° Work executed in the interests of safety, or national defence or of any branch of the public service;

3° Extraordinary pressure of work.

As regards the mobile staff, the present regulations, which are only provisional, do not impose any limitation of the amount of overtime, and in the three cases enumerated above any modification in the normal regulations is subject to the approval of the Ministry of Public Works (Railway administration section).

This section of the Ministry of Public Works may further, where circumstances justify it, authorise slight modifications in the normal working hours of the mobile personnel.

As regards the stationary staff, the decree of the 14 September 1922 fixed at 450 the number of hours' overtime which may be required of the staff in case of extraordinary pressure of work.

At present (under the « régime » instituted by the decree of the 16 January 1925) the discretionary limit allowed to railways has been reduced from 450 to 75 hours per annum, with a maximum of 2 hours per day, and a railway which wishes to take advantage of this facility must first advise the Labour Control Service of its desire to do so.

Further, the Minister of Public Works may, on the application of a railway, authorise 100 additional hours' overtime work beyond the 75 hour limit, but so that the length of any one working day shall not exceed the normal length by more than 2 hours.

For the execution of urgent work necessary to prevent, or repair the results of, accidents, stationary employees may be required to prolong their attendance at the place of work on any one day, without limits, at the discretion of the service superintendent, and on subsequent days they may be required to work for not exceeding two hours beyond the length of the normal working day.

For work executed in the interests of safety or of national defence, the limit must be fixed in each case by the Minister of Public Works.

The number of hours worked by stationary staff owing to extraordinary pressure of work, or for any other special reason, are considered as overtime and paid for at the ordinary rates applicable to normal working hours.

When, however, the overtime is due to the necessity of executing exceptional work, or to special movements arising out of a serious accident, or when it is demanded of an employee who has already begun a period of rest, the employee thus working overtime is entitled, under the staff regulations, to an increase of 20 % above the ordinary hourly rate of pay in respect of each hour worked up to 2 hours after the termination or before the commencement of the period of work fixed by the scheme of work, and to an increase of 50 % beyond such ordinary hourly rate in respect of each hour worked beyond 2 hours after the termination or before the commencement of the said period of work.

These increased rates are moreover paid whether the hours of overtime are or are not counterbalanced by a corresponding period of rest.

The overtime worked by mobile staff is also accounted for at definite hourly rates of pay, which correspond more or less to the normal hourly remuneration of the employees concerned.

Finally, the French regulations provide that when work has been interrupted for accidental causes or for reasons of « force majeure », a prolongation of the working day may be required under the following conditions to make up for the hours lost :

a) in case the interruption of work does not last for more than one day, the time lost may be made up within a maximum period of fifteen days, dating from the day on which work is resumed;

b) in case the interruption lasts for not exceeding one week, the time lost may be made up within a maximum period of sixty days;

c) in case the interruption lasts for more than one week, the time lost may be made up within a period exceeding the limit of sixty days, but only with the consent of the Labour Control Service.

The above provisions cannot be construed to authorise the prolongation of the working day beyond a maximum of 10 hours.

The *Belgian* law of the 14 June 1921 provides that the normal limits may be exceeded when it is necessary to execute work either to repair the results of, or to prevent, an accident, as well as urgent work on engines and rolling stock and work necessitated for reasons of « force majeure » or for unforeseen reasons; but only when it is absolutely indispensable to execute such work outside ordinary working hours so as to avoid serious inconvenience to the service.

The overtime work which may be done under these legal provisions must be paid for at a rate which is at least 25 % higher than the ordinary rate of remuneration for the first two hours' overtime, and 50 % higher for any additional hours beyond the first two (it is to be understood that the above applies only to hours of overtime on any one day and without break of continuity). These provisions are adopted on the *Belgian State Railways*, but the hours of overtime worked by the mobile staff are always paid for at a rate which is 50 % higher than the normal rate of pay, payment for overtime being made once a month.

Overtime work on Sunday is paid for at double the normal rate of pay.

On the *Swedish State Railways* when, as the result of uncontrollable events, accidents or unforeseen circumstances, the normal course of work is interrupted or disturbed, or when there is a possibility of such interruption or disturbance occurring, the working day may be prolonged to the extent demanded by the circumstances. If such prolongation continues for more than six consecutive working days, the authority of the Royal Administration must be obtained.

In all other cases when special circumstances necessitate the extension of the working day, such extension may be authorised by the service superintendents, subject to a maximum limit of 30 hours' overtime in any one month, or 150 hours in the course of a year.

Under the provisions of the *Czechoslovakian* law regarding the 8 hour day, the Minister for Railways may authorise a prolongation of the working day when the ordinary railway service has been interrupted as a result of accidents or because of weather conditions, or, further, when the public interest or other imperative reasons necessitate the working of overtime.

The hours of service may be extended at the discretion of local superintendents in case of train delays.

The regulations in force on the *Japanese State Railways*, the *Greek State Railways*, the *Roumanian State Railways*, the *Danish State Railways* and the *Norwegian State Railways* also provide that in case of accident, whether actual or threatened, working hours may be prolonged and the periods of rest modified or reduced. But the majority of the replies received to the questionnaire do not contain any very precise details as to the extent to which the normal working hours may be modified, nor as to the rates of remuneration applicable to overtime work.

We may remark, however, that in *Roumania* hours of overtime worked by the locomotive staff are paid for at 20 % above the normal rate of pay.

Obligation to execute the work allotted.

We have seen that in most cases the regulations provide for the modification of the rules relative to working hours and rests in certain well defined cases. The same applies to most industries, where it is possible to lay down conditions in advance as to the working of overtime.

But the very nature of the railway service gives rise to accidental and unforeseeable circumstances, necessitating the working of overtime, as for instance in the case of train delays.

It is therefore essential that employees should be required, in the case of modification of the normal hours of work, to carry on the duties which are assigned to them, in the interests of the public service. This obligation is expressly stipulated in the regulations of certain railways. Thus, for example, the regulations of the *Belgian State Railways* stipulate that in no case, even when the maximum working hours are exceeded, must train staffs abandon at any intermediate station the public service with which they are entrusted, but stationmasters must take all necessary measures for accelerating the dispatch of trains in the direction of a station or depot where the train staffs can be changed.

In no case, however, and under no pretext, must an employee who has reached the maximum number of hours authorised be compelled to continue a journey beyond the first point on the line at which it is possible to replace him, and the employee concerned has the right to spend the night at such point.

Disciplinary action is taken in the case of employees who endeavour to secure their replacement contrary to the regulations, as well as in the case of those who, having been formally requested to continue at their post, are found to have defaulted.

In case of accident, or definite interruption of the service, employees cannot claim the application of the standing regulations, in order to justify their refusal to execute the additional work which is required of them.

On the *large French railways*, whatever be the category of the employees, they cannot, under any circumstances or pretext whatsoever, when requested to prolong their hours of work or to reduce their period of rest, leave their posts or refuse to execute the work assigned to them.

In *Czechoslovakia* all employees are required to execute the duties assigned to them, even outside the normal working hours. Any infraction of this rule renders the employee concerned liable to disciplinary action.

In *Roumania* the law and the railway regulations provide that employees whose work is connected with the safety of traffic may not, when requested to prolong their normal working hours, leave their post before they have been relieved.

On the *Japanese State Railways* all employees are required to carry out the duties assigned to them by their superior.

Emergency obligations.

Apart from the cases referred to above, where employees may be required to *prolong* their normal working hours, it may be necessary in certain circumstances to recall employees who have already entered upon a rest period.

To meet this case the *Japanese* regulations provide that in case of accidents all employees are required, on their own initiative, to place themselves at the disposal of their superior.

On the *large French railways* it is provided that certain employees (and in particular reserve superintendents whose duty it is to undertake relief work as drivers, stationmasters, etc., or whose assistance is necessary in case of defects in fixed installations or apparatus of importance as regards the safety or punctuality of the train service) may be called upon during rest periods if their services are urgently required.

The service regulations may, in this respect, adopt whatever provisions may be necessary to authorise the calling up of such employees, during rest periods, where circumstances require it.

Intervention of the staff in questions concerning the application of service regulations

The regulations in force on certain railways give employees the right to express an opinion at the time of drawing up working timetables, or to submit observations or objections on the subject of working conditions.

In *Norway* and *Poland*, for example, the staff has the right, through its representatives, to express its views on the organisation of the service in general and on the timetable of work in particular.

In *Roumania* any observations which the employees may wish to make must be made to their immediate superior.

On the *Czechoslovakian State Railways* the timetables of work are prepared in collaboration with representatives of the staff.

Any objections which may be raised to these timetables by the staff or its representatives are considered by the administration.

In *Denmark* the timetables of work are, prior to being adopted, submitted to the staff, who may submit any observations or objections within the period of one week.

On the *Swedish State Railways* timetables of work are submitted to the staff concerned before being put into force, and they have the right, within a period of six days, to submit any observations thereon to the Local Superintendents. Where necessary, any difference of opinion can be submitted to the Royal Administration, which gives its decision after consulting a Special Commission composed of a chairman and six members; the chairman and three of the members of this Commission are nominated by the Royal Administration and the three other members by the employees' unions.

This Commission gives its opinion on the following questions :

1° Prolongation of the working hours of employees engaged in intermittent work;
2° Claims emanating from the staff;
3° Examination of questions submitted by the Administration;
4° Drafting of regulations.

Where claims are submitted by employees, the Commission must grant a hearing to both the competent authority and the claimants.

On the *large French railways* the staff may, further, submit its observations either in person or through the medium of delegates recognised as such by the Regional Superintendents and by the higher central authorities.

As regards mobile staff, the present provisional « régime » provides for the participation of the representatives of such personnel in the work of the « Labour Committees » which every month examine the timetables of work and the cases of work outside the limits of the timetable which have occurred during the preceding month.

Finally, the law of the 29 October 1921 relative to the new situation on the railways provided that any dispute of a collective nature which may arise between one or more railways and the personnel, particularly as regards service regulations, shall be referred to an arbitral tribunal comprising two representatives of the staff.

Under the regulations instituted by the decree of the 16 January 1925, difficulties of a local or regional nature relative to the preparation and application of service time-tables are to be settled by the Labour Control Service, after hearing the observations of the parties concerned and of the representative of the railway administration. The delegate representing the staff may be heard at his request or at the request of the staff.

Difficulties of a general character must be settled by the Minister of Public Works, who will give his decision after consultation with the Director of the Labour Control Service, the latter having previously consulted a tripartite Commission comprising an equal number of representatives of the Administration, of the railways, and of the employees' organisations.

On the *Belgian State Railways* observations may be presented either in writing or by word of mouth by the staff or by delegates of the « Employees' Councils ». Such observations are received by the superintendent concerned, and are examined by both parties. When it is not possible to arrive at an agreement as a result of such exmination, the dispute is submitted to higher authority for decision.

Holidays.

Apart from so called « rest periods », the staff is entitled in most countries to an annual holiday, generally with pay.

On the *Japanese State Railways* employees who have not been absent from work during a period of six months are entitled to a holiday of three or four days. If in the course of the ensuing six months there is again no absence, the employees are entitled to an additional holiday of from four to six days. The same rule applies to all subsequent periods of six months during which the employee is not absent from work.

The holiday must be taken within a period of one year at a time chosen by the employee, subject to conditions permitting of such choice. The work of employees absent on holiday is carried out by the remaining employees, who work overtime as required.

In cases of the decease of near relatives (father, mother, son, daughter) leave of absence with pay of from three to five days is granted to employees, who are further entitled to a day's leave of absence on each anniversary of the decease of their father or mother.

In cases of the serious illness of parents, wife or children, or in similar cases, employees may obtain permission to absent themselves from work when they have made arrangements for their work to be carried out for them during their absence.

On the *South Manchuria Railway* a holiday of twelve days is granted to higher grade staff and officials; workmen are only entitled to holidays in case of the decease of parents, children or wives.

In the regulations of certain railways the length of the annual holiday depends on the number of years of service. Thus:

1° On the *Greek State Railways* stationary employees are entitled to holidays as follows :

Shunters :

10 days a year for those who have completed from 2 to 10 years' service;
15 days a year for those who have completed more than 10 years' service.

Officials :

20 days a year for those who have completed from 1 to 15 years' service;
30 days a year for those who have completed more than 15 years' service.

2° In *Denmark*, where the staff is entitled to 52 rest days, holidays with pay are granted as follows :

1 week for gatekeepers and engine shed employees;
2 weeks for employees working on the permanent way, porters, train staffs, firemen;
2 to 3 weeks for head guards, drivers, and assistant stationmasters.

3° In *Luxemburg* employees are entitled, in addition to 52 rest days per annum, to the following annual holiday :

15 days, when they have completed from 1 to 5 years' service;
21 days, when they have completed more than 5 years' service.

In addition to this paid holiday, which does not entail the working of any overtime, employees may be granted leave of absence with pay in case of the decease or birth of a member of the family.

4° In *Poland* the annual holiday may vary from 2 to 6 weeks, according to the length of service of the employees concerned.

This annual holiday is in addition to the 26 rest days per annum, and employees are not required to work extra time on account of such holiday.

5° In *Roumania* the holiday varies from 10 to 30 days.

6° In *Holland* the annual holiday consists of 14, 18 or 21 days, according to the number of years of service.

7° In *Czechoslovakia* the annual holiday is granted on the following scale :

2 weeks for employees with less than 10 years' service;
3 weeks for employees who have completed from 10 to 20 years' service;
4 weeks for employees who have completed more than 20 years' service.

Apprentices and employees of the lower grades are entitled to shorter holidays, but in their case also the exact duration of the holiday depends on the length of service.

On the *Swedish Railways* employees on the permanent staff are entitled to a yearly holiday with pay, on the following scale :

	Employees under 40 years old.	Employees more than 40 years old.
Lowest grades. . . .	20 days.	30 days.
Middle grades. . . .	25 days.	30 days.
Higher grades. . . .	35 to 45 days.	45 days.

In *Norway* the yearly holiday consists of from 2 to 3 weeks.

In addition to the 59 rest days per annum, holidays on full or part pay may be granted to employees of the *Belgian State Railways* as follows :

15 days per annum to officials, office staff, and attendants;
4 days per annum to drivers.

Holidays on full pay may also be granted to employees of the permanent or temporary staff to enable them to fulfil certain civic duties or to attend certain family ceremonies (funerals, marriages, etc.).

On the *large French railways*, under the terms of the staff regulations which came into force in 1920, employees are entitled to an annual holiday, with pay, of fifteen days. This period has, moreover, been voluntarily increased to a maximum of thirty days, in the case of the higher grades of employees, and particularly those of the traffic service who may be called upon to work outside the normal working hours, whether to undertake a special inspection or to take part in any action which may be necessary as the result of accidents or other occurrences.

Under the « régime » instituted by the decree of the 14 September 1922, the granting of this fifteen days' holiday might entail an obligation on the part of the employees to make up the 120 working hours thus lost; employees were, in fact, required to work 2 504 hours per annum, which represents the equivalent of 313 working days (365, minus 52 Sundays).

Under the new « régime », instituted by the decree of the 16 January 1925, employees are no longer required to make up the time taken in holiday.

Summary of regulations in force on the German State Railways with regard to working conditions.

It may be useful to add to our report some details concerning the rules at present in force on the German railways with regard to conditions of work.

On the German State Railways employees are divided into two main categories, each having its own set of regulations:

a) Officials (Beamte);
b) Workmen (Arbeiter) (¹).

a) *Officials.*

1° *Hours of work.* — The number of hours of actual work must not, on the average, exceed:

8 hours per working day;
48 hours per period of seven days;
208 hours per period of thirty days;

when work is continuous and particularly fatiguing. Mere continuity of work is not sufficient to justify limitation to 8 hours.

The following are considered as occupations in which work is continuous and particularly fatiguing:

In stations: Chief Traffic Official, pointsmen and shunters in cases where the service operations follow on in such a way that there is no interruption, not even for so short a space as five minutes.

In other occupations, the period of work must not exceed the following limits:

9 hours per working day;
54 hours per period of seven days;
234 hours per period of thirty days.

The time spent in going to the place of work, or from one post to another, counts as time spent in actual work.

The time during which employees are required to be present at the place of work,

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(¹) The term « workmen » (in German: *Arbeiter*) is applied to employees in any branch of the service, even outside workshops. The « workmen » comprise about 70 °/₀ of the total staff, and include labourers and certain other lower grade employees of all branches of the railway service.

without actually doing any work (*i. e.*, available for work if required), is accounted for, when calculating the period of actual work, as follows :

a) for staff of the permanent way inspection service, at the rate of 33 1/2 %;

b) for station staff, at the rate of 50 %;

c) for train staffs and engine crews, at the rate of 50 %, except in cases where the stand-by crew for a particular engine is the same crew as will run the engine, in which case the time spent in this way counts as actual work to the extent of 80 %.

Journeys on the line to reach or to return from the place of work are counted as periods of actual work to the extent of 50 % of the time so spent.

2° *Daily rest.* — The daily rest must be of at least 8 hours' duration in the case of station employees or employees engaged in inspection of the permanent way, as well as in the case of train staffs or engine crews who take the rest away from their place of residence.

The minimum is 10 hours in the case of train staffs or engine crews who take the rest at their homes.

These periods may, however, where required by the exigencies of the service, be reduced to 5 hours in the case of the mobile personnel and to 6 hours in the case of other employees.

3. *Limits of working day.* — Where it is a question of work which is continuous and particularly fatiguing, the maximum period of work must not exceed 10 hours.

In other cases the limit may be extended to 12 hours, and, further, may be prolonged to an extent equivalent to the intervals between work and to the periods spent in reserve at the place of work, the maximum in such cases, however, not to exceed 16 hours.

These general rules are replaced, in the case of the train staffs and engine crews by the following :

The limit must not as a rule exceed 12 hours. It may, however, be extended to 16 hours in the case of very light work, or where there is a break of 2 hours, or, further, if a prolonged rest period is to precede or follow the period of service in question.

The maxima of 12 and 16 hours respectively may also be exceeded in certain cases.

As regards engine crews, the time spent in actual running during any one day must not exceed 9 hours, except in the case of very light work and provided a break is allowed during the day.

4° *Periodical rests.* — The staff is entitled, annually, to :

a) either 52 rest days each consisting of at least 32 consecutive hours;

b) or at least 26 rest days of the above minimum duration and the remainder at the rate of 3 rest days of 24 hours each for 2 rest days for 32 hours each.

Rest days should comprise, wherever possible, 17 Sundays or public holidays.

5. *Night work.* — Night work which includes more than one hour between midnight and 4.0 a. m. must not be required of employees on more than seven consecutive nights (four nights in the case of engine crews and train staffs).

6. *Timetables of work.* — Timetables of work are drawn up after consultation with the employees' representatives. In case of dispute the final decision rests with the departmental superintendents.

7. *Overtime work.* — In cases of *force majeure* or unforeseen circumstances, such as train delays or dislocation of traffic, the railway administration, through

the local officials may require employees to work overtime.

b) *Permanent workmen* (*Arbeiter*).

The period of work, inclusive of breaks, may not exceed 10 hours per day or 60 hours per week.

In workshops the regulation period of work is 9 hours per day or 54 hours per week.

In the case of employees of the permanent way maintenance service (and employees in all open-air branches of the service, such as building, quarrying, ballasting, etc.) the regulation period of work varies from 6 to 10 hours according to the season, and is arranged in such a way that the average does not exceed 9 hours per working day.

In the case of employees engaged as attendants, office boys, caretakers, or in similar occupations, the period of work is regarded as half the period of attendance, but the latter period may not exceed 12 hours per day.

In workshops, in the case of work preceding or following the normal period of work (for example, lighting and heating), payment is made at overtime rates.

Overtime work is defined as work in excess of the 60 hours weekly maximum, or, in the case of employees engaged in maintenance work on the permanent way, work which exceeds by more than 6 hours the normal weekly maximum applicable to the particular section of work.

Overtime of less than 10 minutes duration does not entitle the employee concerned to the overtime rate of pay.

Summary.

The foregoing report, which we have endeavoured to render as exhaustive as the information at our disposal would permit, throws into relief the very divergent nature of the regulations with regard to working conditions adopted by the different railways in the countries with which the report is concerned.

These regulations differ, in fact, not only in the method of application, but, more important still, in the basic principles which underly them. This, however, is not altogether surprising, for the regulations now in force are necessarily inspired by the regulations which they have replaced, and such former regulations, having no common origin, necessarily reflect the local customs and ideas of the countries or localities concerned.

It may safely be said that as a general rule the regulations in force in the countries of Western Europe are characterised by the condensation of work into as short a daily period as possible, by a more or less equal distribution of work between the consecutive days, and by the reduction to a minimum of variations either above or below the average period laid down by the regulations.

These characteristics probably result from a desire to approximate as closely as possible to the conditions obtaining in other large industrial undertakings.

The condensation of work is, it is true, facilitated in the case of certain railways, or certain branches of railway work, by the density of traffic; but the generalisation of the principle may present serious difficulty in numerous cases, and may prevent the most efficient possible utilisation of the services of the staff.

A system which is, for example, possible in a workshop, where the work is executed by consecutive shifts with a more or less uniform standard of output, may be unsuited for a large number of branches of railway work, in which the work demanded depends above all on the train service and the needs of the public.

These latter factors can only be allowed for in a very imperfect manner when the regulations adopted are too rigid. Account must be taken of the requirements of the industry's customers.

On the other hand, on the railways of Central and Eastern Europe, there does not appear to have been the same effort to approximate to the conditions of work obtaining in industry in general; and, either for this reason, or because national customs lend themselves more easily thereto, there is noticeable a less equal distribution of work between different working days. It is also apparent that in order to be in a position to grant longer daily rests, these railways do not hesitate to resort to a longer average working day than is found on the railways of Western Europe.

The same contrast with the conditions obtaining on Western European railways also exists in the case of the railways of the Far East.

* * *

In spite of these divergent tendencies, it is possible, in respect of the whole of the various sets of regulations which we have had under review, to draw certain conclusions, which we have divided into three categories, as follows :

1° Conclusions applicable to the whole staff;

2° Conclusions relating exclusively to mobile staff;

3° Conclusions relating exclusively to stationary staff.

Conclusions applicable to the whole staff.

1° It is most important that the average length of actual work should be calculated over as long a period as possible, preferably over the whole year, so that the railway may be in a position, without employing an excessively large staff, to deal with sudden rushes of traffic, and to make up for working time lost for various reasons, particularly as a result of inclement weather, the varying length of days and nights, and unforeseen occurrences or accidents.

2° A distinction should be drawn between actual work and merely light or intermittent work, in order that the effective output of employees may approximate as nearly as possible to the limit laid down by the regulations.

3° Whether in the case of actual work or intermittent work, it is desirable, without however exceeding the permissible limits, to lay down sufficiently wide limits, variable according to the nature of the work and to the housing conditions of the employees concerned.

4° Any limitation as regards the intervals between periodical rests leads to a limitation of the duration of such rests, thus making it impossible to modify the regulations to suit the personal convenience of different employees.

5° With a view to retaining the maximum of elasticity in the regulations necessary for the proper conduct of the railway service, and in order to avoid possible difficulties in the application and interpretation of such regulations, it is desirable that they should be as simple as possible.

If the regulations with regard to conditions of work provide for the settlement of any disputes which may arise between employers and employees as to the application or interpretation of such regulations, it is desirable that the procedure contemplated should be as expeditious as possible and require the intervention of the least possible number of parties.

6° If the most effective possible utilisation of the staff is to be obtained, it is essential that all employees should be fully aware of the conditions and difficulties obtaining in other sections of the service, and to secure this it is necessary that there should be a sufficient degree of interpenetration between the different sections.

In the case of certain important centres it may be desirable to effect this interpenetration by the appointment of officials whose duty it is to co-ordinate the work of the various sections of the service (ordering and running of scheduled and special trains, arrangements for the provision of engine crews and train staffs, liberation of engines and crews after the normal period of work, etc.).

7° It is frequently possible to meet the requirements of the service with a minimum of staff by not hesitating to entrust the execution of the work of one section to the staff of another section, although this may not be in accordance with the normal scheme of work.

For example, in shunting yards of small or average size, the use of loco-tractors (internal combustion), driven by employees of the yard, is a less expensive substitute for a shunting engine which, to carry out a few hours' work daily, would have to be detached from a neighbouring depot.

8° It is sometimes possible, when the employees of one section of the service are not constantly or fully occupied, to use them on the work normally belonging to another section.

Thus, the gatekeeping at certain level-crossings may be combined with service at a main line signalling post in the immediate vicinity, or with service at the neighbouring station.

It is with a view to effecting this interchangeability that in certain cases the mobile staff of a railway is required to carry out other duties than the running of trains during unoccupied intervals.

Conclusions relating exclusively to mobile staff.

9° In the case of mobile staff, even more than in that of stationary staff, the limits of the working day influence the effective output of such employees.

10° In order to avoid unproductive journeys, whether for employees or for engines, it is necessary to observe the utmost elasticity in the arrangement of turns of service. In particular, to allow for the frequent disproportion between the volume of traffic running in the two opposite directions, it is desirable to adopt the triangular arrangement of turns of service If this is to be possible, however, it is necessary not to impose too strict a limit on the number of days during which an employee may be absent from the place of residence nor on the minimum duration of rests taken away from the place of residence.

11° Accessory work, such as the preparation of engines and their return to the engine shed, represents an important part of the work of engine crews.

It is often desirable to allot this accessory work to employees other than those who actually drive the engine.

12° In order to avoid the necessity for keeping an unproductive staff in reserve in case of emergency, and to obtain a more efficient utilisation of the staff as a whole, it is necessary that the regular timetable should comprise the maximum number of trains to be run, thus limiting the number of special trains to the actual daily variations in traffic.

On the other hand, it is essential that, in calculating the total period of effective work done, only periods of reserve or waiting during which employees are unable to rest (whether because such periods are too short or for any other reason) should be taken into account at the full value of their duration.

13° The punctuality of train movements is an indispensable factor in the effective utilisation of the personnel and in the reduction of useless effort.

Conclusions relating exclusively to stationary staff.

14° The reduction of effective output is most apparent in those branches of the service where the work is dependent on the train service or on the requirements of customers.

It is possible to improve this output by concentrating the maximum number of operations in as small a number of posts as possible. The use of cabins with a wide range of action, or the concentration of work in offices, are among the means whereby output may be partially increased.

Operations which are not of a technical nature (cleaning, handling of goods, etc.) may with advantage be done by contract, thus avoiding too great a dispersion of the energies of the technical staff.

15° Every improvement in equipment (multiplication of telephonic apparatus to avoid useless waiting and movement of the staff of different branches of the service, provision of tractors for dealing with goods and parcels, use of electric motors and electric lighting) helps to improve the output of the staff.

16° In order to avoid the necessity of increasing the number of employees engaged (especially in night work), so as to be prepared for any possible breakdown of apparatus or disturbance in the normal working of traffic, it is very desirable to arrange that at any rate part of the staff should live wihin a certain distance of the place of work. It is accordingly desirable that dwellings should be provided, either free or in return for a rent proportionate to the means of the employees concerned.

17° In order to be in a position to cope with seasonal rushes of traffic without being compelled to engage temporary and inexperienced staff, it is desirable that the regulations should be sufficiently elastic as regards hours of overtime.

18° As regards temporary staff, it is desirable that they should be subject to regulations which, while not exceeding a certain maximum period of work, allow of sufficiently wide limits to enable the temporary employees to execute completely the duties of the employees whom they replace.

It is further obvious that, with a view to avoiding loss of time in proceeding to and from the place of work, temporary employees should as far as possible be domiciled in the same district as the employees whom they replace.

19° For the conveyance of employees between the assembly point and the place of work (and, to a certain extent, for the inspection of the permanent way), the use of hand trolleys reduces the amount of walking and thus increases the amount of actual work done by the employees.

[621 .133 & 621 .137.1]

REPORT No. 3

(all countries, except America and the British Empire)

ON THE QUESTION OF REDUCTION OF THE COST OF TRACTION : FUEL AND ITS COMBUSTION (SUBJECT IV-*A* FOR DISCUSSION AT THE TENTH SESSION OF THE INTERNATIONAL RAILWAY CONGRESS ASSOCIATION), (1)

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The Permanent Commission of the Association has limited the study of the question of fuels to the following points :

a) Choice of fuel : coal, mixing of coals, peat, oil fuel, pulverised fuel, mixing of solid and liquid fuels (colloidal fuel);

b) Apparatus for the combustion of solid fuel (rocking-grates, etc.), liquid and pulverised fuels;

c) Mechanical stokers;

d) Smoke consumption. Spark-arresters.

The report based on the information received from the various railways will, for greater clearness, be divided into two chapters. The first will deal with question *a*, the other with questions *b*, *c* and *d*. Further, the order followed in each of these chapters will be that of the list of questions sent to all railways, the text of which will be reproduced at the beginning of the chapter.

The report will be followed by a summary, in which we shall set out the results of our investigation which in our opinion should be laid before the Congress.

CHAPTER I.

Choice of fuel.

LIST OF QUESTIONS.

Question *a* :

I. — *Special regulations relating to the supply of solid or liquid fuel for use in locomotives* (Cahiers des charges).

II. — *Principal characteristics of the different kinds of fuel.*

III. — *Organisation of the receiving service :*

1° *Number and duties of employees engaged in this work;*
2° *Laboratories;*
3° *Analyses and tests;*
4° *Methods adopted;*

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(1) Translated from the French.

5° *Methods of checking the quality of the fuel received.*

IV. — *Methods of purchase of fuel (open tenders, restricted tenders, direct purchase, long-term contracts, contracts at fixed prices, contracts at prices on a sliding scale, etc.).*

V. — *Is the fuel paid for at a fixed price, or is the price dependent on the quality of the fuel delivered (calorific power, evaporative capacity, percentage of ash, percentage of moisture, etc.)?*

In the latter case, what are the scales of payment adopted?

VI. — *Details relating to the use of fuel in locomotives.*

VII. — *Comparison between the different net costs in table 2.*

Explanation of each of these net costs, and justification of the use of fuel with a high net cost.

VIII. — *In cases where the kinds of fuel used necessitate preparation or mixing, how are these operations carried out?*

IX. — *Regulations relating to the storage of fuel, from the point of view of :*

1° *the geographical situation of the depots;*

2° *the size of stocks.*

X. — *State what tables of net costs of fuel :*

1° *are at present kept by your railway; or 2° it would be desirable to adopt so as to arrive at a standardised statistical table allowing of ready comparison between the different railways.*

Belgium.

STATE RAILWAYS.

I. — The Belgian State Railways use in their locomotives :

Small coal 0/70 (1) hard and quarter-rich to the extent of 12 % of the total consumption;

Small coal 0/70 half-rich in the proportion of 46 % of the total consumption;

Rich small coal 0/70 in the proportion of 11 % of the total consumption;

Rich rough coal in the proportion of 13 % of the total consumption;

Rich screened coal in the proportion of 6 % of the total consumption;

Briquettes in the proportion of 12 % of the total consumption.

Special conditions relating to small coal :

This coal must be dry, evenly grained, recently mined and free from stone, clay, etc. It must not contain pyrites, and must not give either a compact clinker which adheres to the grate, or ash of such a nature as to render satisfactory firing difficult during the run.

N. B. — No conditions are laid down with regard to the composition of small coal. The varieties used are generally of Belgian origin, and contain a maximum of 40 % of 0/2, and at least 10 % of lumps above 30 %.

Hard coal. — The percentage of ash must not exceed 20 %. The price of the fuel is based on a percentage of ash which must be stated in the specification and which serves as a basis for calculating fines or premiums, as follows : each unit of difference between the actual percentage of ash, as determined in the laboratory of the district, and the basic percentage stated in the specification, will, in the case of each delivery, entail a reduction or increase of 2 1/2 % in the basic price of the coal, according as the difference is positive or negative. If the percentage of ash is between 17 % and 20 %, the figure of 2 1/2 % is increased to 3 %.

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(1) These figures refer to the size of round hole, in millimetres diameter, in the screens. (*Editor English edition.*)

The weight of water contained in each delivery in excess of 3 %, as determined in the laboratory of the district, will be deducted from the actual weight of the fuel.

The proportions of ash and of water will be expressed as percentages calculated to the second place of decimals, the figure of the second decimal place being taken as the next highest if the third decimal place is more than 5, and as the next lowest if the third decimal place is 5 or less than 5.

The corresponding fines or penalties are expressed in francs, calculated to two places of decimals.

Hard small coal must contain from 8 1/2 % to 11 1/2 % of volatile matter.

Quarter-rich (1) *coal.* — Same conditions as above. Limits for volatile matter : 11 1/2 % to 13 %.

Half-rich coal. — Same conditions as above. Limits for volatile matter : 13 % to 18 %.

Rich coal. — Same conditions as above. Limits for volatile matter : 18 % to 23 %.

In addition, the caking qualities must be such that a mixture composed of 35 % of this coal and 65 % of inert matter (quartz) shall still give a compact coke.

Briquettes. — *Nature of the pitch and quantity to be used.* — The pitch must be dry or half-rich, and be derived exclusively from coal tar.

The percentage of moisture must not exceed 1 %, and the same percentage applies to ash. Distillation in a closed vessel in a reducing atmosphere must produce as residue a swollen coke, the weight of which must not be less than 30 % of the weight of the quantity tested.

The proportion of pitch used in the briquettes must not exceed a maximum of 10 %.

Physical characteristics of briquettes. — The briquettes must be compact, sound of uniform weight, unbroken, and have sharp edges.

When broken they should show a clear bright break, and a fine, close and even grain.

They must be hard and retain all their hardness at 50° C. (122° F.).

They must possess a degree of cohesion of at least 55 %, determined in the following manner :

50 kgr. (110 lb.) of briquettes, broken into pieces weighing about 500 gr. (1.10 lb.), are placed in a sheet iron cylinder the internal diameter of which is 90 cm. (2 ft. 11 1/2 in.) and the length 1 m. (3 ft. 3 3/8 in.). The cylinder is divided into three equal compartments by means of longitudinal partitions projecting 20 cm. (7 7/8 inches). When the pieces of briquette have been placed inside, the cylinder is closed, and it is then made to revolve 50 times in two minutes.

The residue is passed through a 3 cm. (1 3/16 inches) mesh screen, and the ratio of the weight remaining on the screen to the original 50 kgr. (110 lb.) gives the degree of cohesion.

Behaviour in the firebox. — The briquettes should light readily without breaking up; they should burn with a sharp clear flame without giving off any sulphur fumes.

Briquettes which produce adhesive clinkers or ash which melts and adheres to the grate must not be used.

Nature of the coal. — The coal used in the manufacture of briquettes must satisfy the conditions laid down for half-rich coal; it must contain from 14 % to 16 % of volatile matter, produce a hard, compact, close-grained coke in the combustion test, and be recently mined.

Composition of briquettes. — The percentage of volatile matter must not be less than 17 % nor more than 22 %.

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(1) The term « rich » refers to the percentage of volatile matter. (*Editor English edition.*)

The melting point of the ash produced in the combustion test, as ascertained in the laboratory at Schaerbeek, must be above 1 350° C. (2 462° F.).

Eeach unit per cent of ash in excess of 10 % or below 9 % will entail, in respect of each delivery, a reduction or increase of 2 1/2 % in the basic price of the briquettes.

If the percentage of ash exceeds 12 %, the briquettes will not be accepted, and must be stacked separately to await a final decision.

The weight of water contained in each delivery in excess of 4 %, as ascertained in the laboratory of the district, shall be deducted from the total weight of the fuel as delivered.

Screened coal. — Screened coal is coal which has passed over screens having round holes of 50 mm. (1 31/32 inches) diameter, or screens consisting of longitudinal bars placed 35 mm. (1 3/8 inches) apart.

Such coal must not be friable, so that it can be unloaded from the wagons, stacked, and reloaded on the tenders without giving an excess of small.

In order to ascertain whether the coal complies with this requirement, a sample of 50 kgr. (110 lb.) is taken, broken up into lumps of from 5 to 12 cm. (1 31/32 to 4 3/4 inches), and then submitted to a test similar to that applied in order to ascertain the degree of friability of briquettes. Of the residue resulting from the test it should not be possible to pass more than 35 % through a screen of 1 cm. (13/32 inch) mesh.

The coal must not contain more than 6 % of ash, and the percentage of volatile matter should be between 18% and 24%.

The melting point of the ash, as ascertained in the Schaerbeek laboratory, must be above 1 350° C. (2 462° F.).

Each unit per cent of ash in excess of or below 6 % will entail, in respect of each delivery, a reduction or increase of 2 1/2 % in the basic price of the coal.

The weight of water contained in each delivery in excess of 3 %, as ascertained in the Schaerbeek laboratory, shall be deducted from the total weight of the fuel. (See the conditions applicable to briquettes, above.)

III. — *Reception of deliveries.* (Extracts from regulations.) — In the case of each delivery of coal or briquettes for use in locomotives, railway officials will take samples in such number as will, when mixed, give a fair representation of the average quality of the delivery.

They will do the mixing themselves, and from the mixture they will take a sample for testing purposes which they will grind finely and sift. The product will be divided into four parts, which will be disposed of as follows :

Two parts will be sent to the nearest district laboratory (Liége, Charleroi, Mons);

One part will be sent to the central laboratory at Schaerbeek.

The fourth part will be retained by the supplier.

Each of these samples will be placed in a container closed with two lead seals, one bearing the mark of the railway official and the other that of the representative of the supplier.

Before the coal is ground, the railway official will take from the mixture the same number of samples of unground coal; these will be placed in containers which will then be hermetically closed and sealed with double lead seals as above. These samples will be distributed in the same manner as the abovementioned samples.

The above operations will be carried out on the spot by means of apparatus which must be provided by the supplier. The necessary containers will be supplied by the State railways. These samples will be used to ascertain the percentages of ash and moisture in the deliveries, on which percentages the appropriate penalties or premiums are based.

The tests will be carried out at the

laboratories on the day following that on which the samples are taken.

The supplier or his representative has the right to be present during the tests. A copy of the report on the tests must be delivered to the supplier not later than the third day after the date of delivery of the coal, legal holidays not being counted. If the supplier does not accept the results of the tests, he must submit his observations by registered letter, addressed to the head of the district laboratory concerned, within three days of receipt of the report. A second test will thereupon be carried out by the laboratory on the day following the date of despatch of the supplier's letter.

This second test will not be carried out unless the supplier or his representative attends at the laboratory to witness the test.

The results of the second test will be regarded as final.

If the supplier does not protest against the report on the first test, or if the letter of protest is not despatched within the prescribed period, it will be assumed that he accepts the results of such test.

When the percentage of ash is found to warrant rejection of the consignment, the quantities already delivered will be considered as accepted, but the scale of penalties contemplated above will be applied to such deliveries.

If circumstances render it impossible to test any given delivery of fuel, such delivery will be dealt with on the basis of the percentages obtained in the three preceding tests on deliveries of the same class of coal.

If the tests gave figures equal to or exceeding 20 % of ash for five consecutive deliveries, or for more than one-third of the deliveries during any one month, the deliveries would be placed on one side to await a subsequent decision and the ordinary tests would be dispensed with. Such deliveries would be subsequently tested, and accepted subject to the imposition of the appropriate penalty, or rejected. Until this decision has been made no more coal of this class will be received.

If the number of results equal to or exceeding twenty were below these limits, the wagons would necessarily be accepted, since their despatch would already have taken place, but their percentage of ash would be taken into account in calculating the monthly average. However high the latter, it would be subject to the rule enunciated above.

The size of the deliveries thus placed on one side must not exceed 10 % of the monthly deliveries.

If the State railway official is not present when the wagons arrive, the supplier may, at his discretion, either dispose otherwise of the wagons and their contents, or hold them up, at the expense of the railway, until the official is able to attend to take samples.

1° The number of suppliers in Belgium is about 90, and deliveries are made almost daily.

The receiving service, as described above, comprising the daily taking of samples and the necessary work in connection therewith, is carried out by a staff of 51 employees. This staff is composed of engine drivers who are periodically detailed for this work. It has been found desirable to place the receipt of coal deliveries in the hands of the men who actually have to use the coal, particularly as the firing premiums of such employees would suffer from any negligence on the part of the receiving staff.

These employees work under the supervision and control of three technical inspectors, who in turn are responsible to the chief official in charge of the department which deals with the supply of fuel.

2° and 3° Three district laboratories, situated in the coal mining areas of the country, carry out daily the analysis of the samples taken by the receiving staff.

The tests are limited to the determination of the percentages of moisture and ash, which percentages serve as a basis for the fixing of the monthly prices payable to each supplier.

In addition there is a central laboratory at Schaerbeek, which is in a position to undertake any kind of analysis required in connection with fuel, that is to say, determination of the percentage of ash, moisture, volatile matter and sulphur; caking capacity, calorific power (by the bomb calorimeter), friability, melting point of ash, and the proportions of the various elements of which the fuel is composed.

This laboratory also contains a fixed locomotive boiler for use in combustion tests. These tests are not intended to ascertain whether the fuel supplied is in accordance with specification, because the specification does not refer to boiler tests. They are carried out with a view to studying the influence of the numerous factors which may affect the efficiency of locomotive boilers.

Thus, so far as concerns more particularly the various forms of fuel, these combustion tests make it possible to ascertain the desirability of certain existing conditions, or at least to fix the limits which in practice it is desirable to apply to these conditions.

The boiler tests are carried out in such a manner as to give a complete heat balance sheet, covering in particular the following essential points :

Heat imparted to the boiler;
Heat lost in the ash;
Heat lost through unburnt gases;
Heat lost through being carried away by hot gases;
Heat lost from the solid fuel carried away by the draught.

The boiler is fitted with all the measuring and recording apparatus necessary for ascertaining the above facts.

4° Methods employed for determining the percentages of moisture, volatile matter and ash in a sample of fuel.

For the determination of the percentage of moisture, volatile matter and ash in fuel, the following process is adopted:

The fuel to be analysed is first of all ground finely, and a sample of from 1 to 2 gr. (0.56 to 1.13 drams), is then taken for testing.

In the first place the percentage of moisture is ascertained as follows. The sample is spread evenly over the flat bottom of a tin-plate *container*, which is then placed in a stove kept at a temperature of 100° C. (212° F.) and left there for about half-an-hour.

Secondly, the percentage of volatile matter is ascertained. The sample is first of all dried and is then placed in a porcelain crucible for half-an-hour at a temperature of 1 050° C. (1 922° F.) in a reducing atmosphere. For this purpose the crucible containing the sample is provided with a cover and placed inside a larger crucible. The inner crucible is completely surrounded by charcoal. The outer crucible also has a cover. The whole is then placed in a muffle heated to the above-mentioned temperature and closed by means of a fire-clay stopper.

In order to ascertain the percentage of ash, the sample is finely ground and spread over the bottom of a platinum vessel, which is placed inside the same muffle as referred to above, except that the muffle is not closed, so that the air can enter. It is kept there until all combustible matter has completely disappeared.

5° The Schaerbeek central laboratory supervises the daily taking of samples by the receiving staff, as well as the analyses carried out by the district laboratories. For this purpose a certain number of wagons, taken from the deliveries, are sent daily to the central laboratory. These wagons are selected by the buying department, which department is independent of the receiving service. Further, this selection is not made until the wagons arrive at the engine sheds. Finally, the buying department only specifies the place of origin of the wagons, the actual numbers of the wagons being selected by the engine shed staff.

The central laboratory, having a skilled staff and being situated at a considerable distance from the district laboratories and mining centres, provides the means of effecting a strict control over the processes adopted for ascertaining the percentages of moisture and ash, whereby the price of deliveries is regulated.

Additional control is afforded by the practical tests carried out on locomotives by engine-driver instructors at all the engine sheds on the railway system. The reports on these tests are compared with the results of the laboratory tests, and serve not only to check the latter but also to determine whether the choice of fuel and the chemical conditions stipulated are properly adapted to the requirements of the various types of locomotives and trains.

IV. — As a general rule the Belgian State Railways purchase their fuel at prices fixed by mutual agreement with the Belgian collieries. The contracts are for a period of one year, but only cover a quarter of the actual requirements; new contracts are made every three months, and the contracts thus overlap so that at any given moment four contracts may be in existence with each supplier.

Prices are subject to revision monthly.

Foreign coal is generally bought on limited contracts of short duration and at fixed prices.

V. — Since 1923 the prices paid to suppliers have varied according to the percentage of ash and moisture in the fuel. Basic prices are fixed for a certain percentage of moisture and ash. For example : in the case of small coal the percentages are 12 % ash and 3 % moisture. For each unit per cent of ash above or below the standard, there is a corresponding penalty or premium of 2 1/2 % of the basic price. Moisture contained in the fuel in excess of the standard is deducted from the nominal weight of the fuel delivered. No premium is payable in respect of percentages of moisture below the standard figure.

VII. — The Belgian State Railways endeavour to reduce the expenditure on fuel (expressed in francs) to a minimum, so far as compatible with the efficient working of locomotives.

The system of firing premiums at present adopted naturally has the desired effect. A standard fuel is prescribed (*e. g.*, 70 % of half-rich small coal and 30 % of briquettes); for any given series of locomotives there is an allowance per kilometre of so many kilograms of this standard mixture. It is on this allowance that economies must be effected in order to earn the firing premium. The quantities of fuel delivered to the driver are not booked out to him at their actual weight, but there is a multiplying coefficient for the weight of each kind of fuel in the mixture which makes it possible to express this weight in terms of weight of the standard fuel. Further, the coefficients of the various kinds of fuel bear the same relation to one another as the purchase prices of such fuel. The drivers, having constantly to use fuel of very varying qualities, purchased at widely differing prices, are led by experience to avoid the kinds of fuel which are most expensive to them, that is to say which, by reason of their high coefficient, increase the figure which represents the consumption of standard fuel.

The drivers are naturally guided in their choice by the driver-instructors, and to some extent also by the railway administration, which indicates the most economical proportions to be observed in each case.

It is for the above reasons that the

briquette, which, compared with other forms of fuel, has almost always cost more than was justified by its actual calorific power, is being used to a constantly decreasing extent. The proportion of briquettes used before the war was 80 % : at the present day it is 12 %.

It may be interesting to record the following fact, noted during the course of the year 1922. During one month only was the price of briquettes in Belgium (in proportion to their calorific power) such as to render their use more economical than that of a number of other forms of fuel delivered during the same period to these railways. The point to be noted is that within not more than fifteen days after the lowering of the multiplying coefficient of the briquette, a very large number of drivers had increased their proportion of briquettes to a degree proportionate to the decrease in the price of this fuel.

The briquette, in spite of its frequent high price, is none the less used to a certain extent. It possesses appreciable advantages from the point of view of facility of storage for the formation of fuel reserves : it suffers little deterioration from handling, and can be kept for a considerable time; finally, its excellent caking qualities render it an excellent base for a fire.

VIII. — Up to the present, in engine sheds which have sufficient available space, the various classes of coal are kept separate; the deliveries to the drivers are made in fixed and definite proportions, and the mixing is done on the tender.

In other sheds the mixing is done when the coal is unloaded from the wagons; the various classes of coal are stacked in layers one above the other, so that when it is re-issued to the drivers, a vertical section is taken from the stack, thus including a portion of each layer.

The Belgian State Railways have recently installed a mechanical coal mixer in the new engine shed at Schaerbeek. The contents of the wagons are tipped into a pit whence they are picked up by a chain and bucket conveyer and deposited in four different overhead hoppers corresponding to the four different qualities of coal. An endless belt passing along the base of these overhead hoppers receives the different qualities in regulated proportions.

This installation is intended to supply the mixed fuel to all engine sheds within a radius of about 31 miles. Daily deliveries of the mixture will be made by means of special hopper wagons.

IX. — 1° The question of the geographical situation of the depots will not arise until the Belgian State Railways have completed the installation of the projected mixing centres. The latter, being intended to feed daily a number of engine sheds, must comprise sufficient accommodation for both mixed and unmixed coal. The number of central installations contemplated is seven or eight, and these will supply the whole of the railway system. The general stock of the railway will thus consist of the quantities held at the mixing centres. It is therefore necessary that these centres should be so situated as to entail the minimum amount of transport between the collieries and the centres on the one hand, and between the centres and the engine depots on the other.

2° The Belgian State Railways keep a thirty days' supply of fuel in summer, and a sixty days' supply prior to periods of heaviest traffic in winter. In the case of briquettes the figures are respectively forty days and eighty days.

X. — 1° The Belgian State Railways fix the cost weekly in terms of kilograms of the standard fuel (see above for definition of this standard), and in francs, per ton-km. and per engine-km. It was not until 1923 that the ton-km. was introduced; prior to this consumption was expressed solely in terms of kilometres.

2° See summary.

SOCIÉTÉ NATIONALE DES CHEMINS DE FER VICINAUX.

(National Light Railway Company.)

I. — In each case a practical test is carried out before a delivery of fuel is accepted.

II. — Volatile matter : 14 % to 18 %, according to circumstances. Percentage of ash : must not exceed 18 %.

III. — 1° An official is in charge of the receipt of all deliveries;

2° Analyses are made at the Brussels laboratory;

3° and 4° Practical tests are carried out on locomotives of different types and on lines of varying gradients;

5° Consumption is calculated in terms of train-kilometres for the various groups of lines in the system.

IV. — Purchases are made when the conditions of the market appear most favourable; and either on limited contracts or as individual transactions at prices subject to subsequent adjustement.

V. — The price paid for fuel remains constant so long as the quality remains the same.

China.

SOUTH MANCHURIA RAILWAY COMPANY.

I. — Coal is obtained from the company's own mines. There are therefore no special regulations with regard to deliveries.

II. — DESCRIPTION OF FUEL.		Fushun coal.	Yentsai coal.	Penshihu coal.
Composition.	Volatile matter.	37.43	7.37	15.28
	Fixed carbon	48.76	78.39	71.41
	Ash	6.93	12.66	12.65
	Moisture	6.80	1.4	0.65

III. — The « commercial department » of the company is responsible for the provision of coal for locomotives and for the reserves kept in the vicinity of each engine shed.

VIII. — The mixing is done in proportions which vary according to the particular engine sheds. The mixing is done by hand on the tender.

IX. — 1° The supplies are stacked in the vicinity of the engine sheds; there are no special regulations in this connection;

2° The stocks consist of from 5 000 to 9 000 tons, according to circumstances.

X. — The average cost of fuel consumed is 10.68 gold yen per ton for all lines.

Denmark.

STATE RAILWAYS.

I. — Since the war no special regulations have been applied with regard to the provision of fuel. Purchases are made on ordinary trade terms.

II. — 1° There are no employees detailed exclusively to receive deliveries of fuel.

From six to twelve men are employed at the place where the supplies of coal are unloaded.

The number of men employed in the holds of ships and in unloading wagons varies according to circumstances, and they are not employees of the Danish State Railways.

2° and 4° Formely, when coal was bought on clearly defined terms, the supplier, when making the delivery, also sent a sample of 5 tons from each delivery to the testing stations of the Danish State Railways. This sample was used in practical evaporation tests and also for laboratory analyses.

The coal testing station possesses a boiler taken from an old locomotive, and the evaporation tests are carried out under conditions which resemble as closely as possible actual working conditions. The coal is weighed, the consumption of water is measured, the ash and clinkers are weighed, the deposit in the smoke box and chimney is collected and weighed, the temperature and vacuum in the smoke box are measured, the temperature of the feed water is recorded, and the boiler pressure is kept constant throughout the whole period of the test.

The evaporation figure obtained (kilograms of water per kilogram of coal) is calculated for feed water at 10° C. (50° F.), and the *evaporative capacity of the coal* is indicated by a coefficient, the vaporisation of *8 kgr. of water from 10° C. per kilogram of coal* (8 lb. of water from 50° F. per lb. of coal) being taken as 100.

The laboratory test is ordinarily confined to ascertaining the percentage of moisture, of ash and of volatile matter. In recent years, however, tests have also been carried out with a view to measuring the calorific value, whereas previously the value of the coal was judged exclusively by the results obtained in the evaporation test.

5° The quality of the fuel is checked as follows :

a) By the certificate given by the colliery;

b) By inspection on delivery, the inspection being carried out on the spot by the locomotive engineer in charge of the depot and a driver;

c) By special trial trips on locomotives in traffic.

IV. — Purchases are made when the occasion appears most favourable, directly from the exporters or their representatives, without previous notice. The decision as to whether a long or a short term contract is to be placed depends on the probable needs of the immediate future. At the present time purchases are usually made at prices fixed in advance (c. i. f. in the currency of the country of origin).

V. — The prices paid are fixed according to the quality of the coal.

VIII. — The fuel is not subjected to any special treatment before being used.

IX. — 1° The coal depots are situated near to ports, near to large engine depots or to terminal stations;

2° The present practice is to keep a stock sufficient for about five months.

X. — 1° There are no special lists of prices;

2° The usual basis is the price c. i. f. plus the average freightage charged at the most important ports of the importing country.

France, Algeria, Tunis and Colonies.

a) France.

STATE RAILWAYS.

I. — For the general train service the French State Railways use solid fuel : small coal, large coal and briquettes; only in exceptional cases are other kinds of fuel used. There are regulations for each class of fuel.

II. — The principal characteristics of the coal used by the French State Railways are as follows :

Half-rich small coal from Cardiff and Newport (Colliery Smalls) :

Nut coal passed through a screen composed of long bars fixed 30 mm. (1 3/16 inches) apart;

Ash not exceeding 15 %; melting point of ash, 1 300° C. (2 372° F.);

Volatile matter at least 16 %; hard coke;

Moisture not exceeding 3 %.

Newport large coal (Colliery screened) :

Colliery screened, being coal passed over the 30 mm. (1 3/16 inches) bar screen;

Ash not exceeding 10 %; melting point, 1 300° C. (2 372° F.);

Compact coke.

We publish a list of approved mines. Not more than 30 % of small coal on unloading at French port.

Briquettes :

Ash not exceeding 10 %; melting point, 1 300° C.;

Volatile matter at least 18 %; hard coke;

Moisture not exceeding 2 %;

Friability at least 55 % on grate with square openings of 30 mm. side.

III. — The State Railways employ a receiving staff consisting of from 1 to 3 men, according to the size of deliveries. They are stationed at the ports of discharge and at the French collieries. These employees are qualified to judge whether the fuel supplied is in accordance to specification; they must be able to carry out or supervise a rapid analysis in case of necessity, though it is not the results of such analyses which serve as a basis for the application of penalties or premiums on the prices paid to the supplier. The receiving staff's only duty is to take the samples intended for the official tests, and to send them to the laboratory. It is on the results of the laboratory tests that penalties or premiums are based.

The laboratory ascertains the percentage of ash and of volatile matter, the nature of the coke, the melting point of the ash, the calorific value (when required), and in certain cases the percentage of free sulphur. Use is made of a muffle for ascertaining the ash, and the Bunsen burner is used for volatile matter, the Mahler bomb calorimeter for ascertaining the calorific value and sulphur contents, and a special compressed air muffle, heated by gas, for determining the melting point of the ash.

IV. — Coal is supplied on short-term contracts, prices being fixed by mutual agreement from time to time. The period of the contract in normal times is twelve months, but in times of uncertainty, as at present, the contracts are of shorter duration. Contracts are almost always entered into at fixed prices, but occasionally there is a sliding scale.

V. — In general a deduction is made if the percentage of moisture or of ash exceeds the limit laid down; if the percentage of ash is below the limit, a premium may be given.

The scales vary according to the price of the fuel. If the maximum percentage of ash is exceeded by n and the price of the fuel is A francs per ton, a deduction is made of $\frac{2n\,A}{100}$ francs per ton.

The total number of locomotives on the French State Railways in 1922 was 4 020.

The number of kilometres run amounted to 82 335 000 (51 161 500 miles), of which 12 810 000 km. (7 959 900 miles) were accounted for by shunting operations involving 1 601 330 hours' work.

Only solid fuel was used : briquettes, large coal and small coal.

The consumption of fuel was as follows :

Per kilometre for main-line engine, 20.01 kgr. (70.99 lb. per mile) ;

Per train-kilometre, 24.05 kgr. (85.33 lb. per train-mile) ;

Per 100 ton-kilometres (including lighting and heating of passenger trains but excluding the tonnage of locomotives), 7.84 kgr. (27.82 lb. per 100 English ton-miles) ;

Per 100 ton-kilometres (excluding lighting and heating of passenger trains but including the tonnage of locomotives), 5.45 kgr. (19.34 lb. per 100 English ton-miles) ;

Per shunting hour, 125 kgr. (275.6 lb.).

The total consumption of fuel was 1 734 520 tons.

VII. — The net cost, whether per kilometre or per ton-kilometre, is a somewhat variable figure, depending on the nature of the trains, the gradients of the line, the type of engine, etc.

VIII. — In principle the fuel delivered to us must be capable of being used without mixing; but certain kinds of coal known to be too hard are mixed with high volatile coal at the depots prior to being used. The mixing is done either with the aid of steam cranes or by hand at the time the coal is stacked or when it is being loaded on the tender.

The fuel is stored at the depots in quantities depending on the consumption of the depots. The depots are, of course, supplied as far as possible from ports in the vicinity.

The size of stocks varies according to the season of the year. We endeavour to procure large supplies during the first eight months of the year, so as to have a *three months'* reserve by the end of August, and thus to reduce deliveries during the last four months of the year, which in the case of our railway is the period of heaviest traffic when few wagons can be spared for the transport of fuel. By the 31st December the supply in hand does not usually amount to more than sufficient for from thirty to forty days.

The net costs worked out each month by the purchasing department are the prices free on wagon at the point where it enters on the railway system, all charges paid; they comprise, therefore, the price of the coal, the cost of transport by sea or by an outside railway company, unloading charges, customs duties and taxes.

ALSACE-LORRAINE RAILWAYS.

I. — *Extracts from Regulations.*

LARGE COAL, COLLIERY SCREENED. — **Composition.** — The deliveries must consist exclusively of coal which has passed over a screen having round holes 80 mm. (3 5/32 inches) in diameter.

ROUGH COAL FREE FROM SMALL. — **Composition.** — The deliveries must consist of coal which has passed over a screen having round holes 35 mm. (1 3/8 inches) in diameter.

BRIQUETTES. — **Quality.** — The briquettes must be made from fresh small coal. In the laboratory test they must give a compact non-friable coke.

When stacked in an exposed position they must not be liable to deterioration.

When used in locomotive fireboxes they must burn without falling to pieces.

Appearance. — The briquettes must be hard, sound and evenly grained, well compact, whole, without cracks or surface blemishes.

Pitch. — The pitch used in their manufacture must be derived exclusively from the distillation of coal; the briquettes must not contain more than 10 % of pitch.

II.

PLACE OF ORIGIN.	Class of fuel.	Ash.	Volatile matter.
		Per cent.	Per cent.
Sarre	Screened [80 $^{m}/_{m}$ (3 $^{5}/_{32}$ inches)].	6 to 8	30 to 35
Sarre-et-Moselle	Ditto.	6 to 8	30 to 33
La Houve	Ditto.	8 to 10	35 to 38
Sarre	Rough coal free from small [35 $^{m}/_{m}$ (1 $^{3}/_{8}$ inches)].	9 to 12	30 to 33
Petite-Rosselle	Ditto.	9 to 12	32 to 35
Ditto.	Ordinary rough coal.	12 to 15	32 to 35
Ruhr	Ditto.	12 to 16	22 to 28
Strasburg-Neudorf . . .	Traction briquettes.	8 to 10	17 to 24
Kehl	Ditto.	8 to 10	17 to 24

III. — 1° One inspector, two technical superintendents, five assistant superintendents, and fourteen technical assistants constitute the staff specially appointed to supervise the fuel supply from mines and briquette works;

2° A laboratory belonging to the railway. Use is made of the laboratories at the mines and works for rapid tests;

3° The laboratory belonging to the railway is in a position to carry out all the usual tests (percentage of ash and volatile matter, melting point of ash, calorific value, quantitative analysis, elementary analysis, drying, friability);

4° Usual methods;

5° Inspection on the spot of the process of clearing the coal from dross, etc., and of the briquette presses. Checking of the tonnage loaded on to wagons. Taking of samples for testing in the railway laboratory.

Extracts from standing regulations relative to screened coal, rough coal free from small and run of mine coal.

Nature of tests. — The coal is tested to ascertain the percentage of ash.

Number of tests. — A test is made in respect of every 400 tons (394 English tons) (or fraction of 400 tons) delivered.

Taking of samples. — The samples are taken by hand and without any particular selection while the wagons are being loaded. About 100 kgr. (220 lb.) of coal is taken out per 50 tons loaded; these samples are grouped and mixed for the purposes of the tests required in respect of every 400 tons (or fraction thereof).

Preparation of samples. — The various quantities taken out of the deliveries are ground, mixed together, and reduced by successive elimination to about 1 kgr. (2.20 lb.) of fuel. The grinding down is then continued until the whole sample will pass through a sieve of the A. L. type (eleven 0.2 mm. [1/128 inch] strands per linear cm.) (13/32 inch). The powder thus obtained is divided into three parts and placed in three special sample boxes, numbered 1, 2 and 3.

Analysis at the mine. — The contents of box No. 1 are analysed on the spot; the results obtained guide the receiving officer in his decision as to the provisional acceptance or refusal of the delivery.

Analysis at the railway laboratory. — *a*) ROUTINE ANALYSES. — Box No. 2 is sent by the control official of the Alsace-

Lorraine railways to the railway laboratory at Bischheim to be analysed there; on the results obtained it is decided whether the deliveries shall be difinitely accepted or refused.

b) SUPPLEMENTARY ANALYSES. — Box No. 3 is labelled and closed with the seals of the railway company and the supplier; it is available in case an additional test is called for as a result of dispute; it is kept in a cupboard fitted with two locks or padlocks, one key being kept by the supplier and the other by the railway official.

In case the supplier disputes the accuracy of the tests carried out in the railway laboratory, the Bischheim laboratory carries out a further test, using the contents of box No. 3 for the purpose. The supplier or his representative is entitled to be present during this test.

The supplier is notified by telegram, at least 48 hours in advance, of the date and time of this test.

The absence of the supplier or his representative does not necessitate the postponement or suspension of the test. In every case the result of this supplementary test is final.

Suspension or cancelling of a contract. — If in the course of execution of a contract it is found that for five consecutive days the percentage of ash in the coal supplied is higher than 6 %, the railway has the right to suspend immediately all further deliveries and even to cancel the contract.

Extract from standing regulations with regard to briquettes. — *Nature of tests.* — The briquettes are submitted to the following tests : 1° test of friability; 2° test to ascertain the percentage of moisture; 3° test to ascertain the percentage of ash; 4° test to ascertain the percentage of volatile matter.

Number of tests. — A test is carried out in respect of every 200 tons (197 Engl. tons) (or fraction thereof) delivered.

Taking of samples. — Samples are taken independenty by a representative of the supplier and an official of the Alsace-Lorraine railways, though the absence of the representative of the supplier cannot delay operations. Out of each wagon, and per 10 tons, at least two briquettes are taken as a sample.

When the total weight of the briquettes from which the samples have been taken reaches 200 tons, these samples are combined for the purpose of testing.

Preparation of samples. — *a*) FRIABILITY TEST. — For the purposes of the friability test sections weighing about 500 gr. (1.10 lb.) each are cut from each of the sample briquettes in sufficient number to make up a total testing sample of about 50 kgr. (110 lb.).

The cohesion test is carried out after *complete cooling* by means of the grinding apparatus (naval type). This apparatus consists of a cylinder of sheet-iron 10 mm. (25/64 inch.) thick, closed by two flat end-pieces also made of sheet-iron (each end-piece has a pin fixed in the centre) and resting horizontally on two supports by means of the two pins.

The internal diameter of the cylinder is 90 cm. (2 ft. 11 1/2 in.), and the distance between the two ends is 1 metre (3 ft. 3 3/8 in.). It has three sheet-iron blades fixed on the inner surface and arranged radially with an angle of 120° between each. The blades are of the same length as the inner length of the cylinder, and are 20 cm. (7 7/8 inches) wide. An opening, which can be closed by a slide, allows of the introduction of the substance to be tested. Into the cylinder are introduced 50 kgr. (110 lb.) of the pieces of briquette, previously split into two parts in the direction of the width. The cylinder is then made to revolve 50 times on its axis in the space of two minutes. The contents are then emptied on to a screen composed of parallel round bars placed 40 mm. (1 9/16 inches) apart, and the pieces remaining on the grate are collected. The degree of friability is determined by the ratio between the weight of the lumps remaining on the grate and the total weight tested.

b) Drying test. — From each of the sample briquettes further portions are cut weighing about 100 gr. (0.22 lb.) each. These portions are broken up into pieces about the size of a small nut and mixed. From this mixture about 300 gr. (0.66 lb.) are taken for the drying test.

Friability test. — The friability of the briquettes is tested independently on the spot by the representatives of the two parties.

The degree of friability must be such that 60 % is retained on the screen.

Drying test. — The test which serves to determine the percentage of moisture in the briquettes is carried out on the spot by the representatives of the two parties.

The percentage of moisture in the deliveries must not exceed 4 %.

Compensation for excessive percentage of moisture. — If the average percentage of moisture in the whole of the deliveries of one month exceeds 4 %, the weight of water represented by the excess percentage of moisture is compensated for, at the discretion of the railway company, either by a supplementary delivery during the following month, or by a deduction of the excess weight of water from the nominal weight of the deliveries for the month in question.

Suspension or cancelling of a contract. — If in the course of execution of a contract it is found that for five consecutive days the limits fixed for the percentage of ash or volatile matter, or for the degree of friability have not been observed, the railway has the right to hold up further deliveries and even to cancel the contract.

IV. — Direct contracts of varying duration according to circumstances; fixed prices, or prices subject to revision according to circumstances or to the term of the contract.

V. — In each contract the price is fixed for each grade of fuel, the qualities to be delivered being those stipulated in the railway regulations.

VII. — The continuance of the use of fuel (screened coal or briquettes), the price of which is high, is justified by the following considerations :

1° The collieries of our locality do not produce sufficient rough coal suitable for use in locomotive fire-boxes, and we are therefore compelled to utilise screened coal;

2° The calorific power of the screened coal being higher than that of rough coal, its use gives a higher production of steam;

3° Briquettes are used because it is possible to store them for a prolonged period;

4° Mixtures of different kinds of fuel are not desirable on our railway system in view of the fact that our mines produce very little small. We should be compelled to procure this latter class of fuel from mines at a greater distance. For this reason the cost of this fuel, which in any case is of poor quality, would be still higher than that of the better fuel which we at present use.

VIII. — No preparation or mixing of fuel is carried out on our railways.

IX. — 1° There is a stock of fuel in the immediate vicinity of each depot. These stocks are built up in order to feed the depots in case, for any unforeseen reason, the collieries are unable to supply the fuel required for the running of trains;

2° These stocks are normaly sufficient for about thirty days.

X. — The average costs are worked out monthly. To the stocks existing at a given date are added the quantities received within the following thirty days. The price per ton calculated on the combined costs of the existing stock plus subsequent deliveries constitutes the average net cost applicable to quantities re-issued during the said period.

EASTERN RAILWAY COMPANY.

I. — This railway has no fixed regulations with regard to fuel. Contracts entered into with suppliers specify the conditions under which deliveries are to be made, the conditions varying according to the nature of the fuel in question. Further, as the various kinds of fuel purchased are always obtained from the same sources, their qualities are well-known. Liquid fuel is not used for locomotives on this railway.

III. — All questions relating to fuel (purchase, reception, invoicing, tests, etc.), are dealt with by the same department (the fuel supply department). Only tests on the results of which penalties are based are carried out by an independent branch of the service — « the rolling stock and traction laboratory ». As regards practical tests on locomotives, these are carried out by a driver, generally in the presence of a representative of the « fuel supply department ».

1° The personnel consists of about forty receiving employees of different grades, distributed according to requirements between the various collieries and ports whence supplies are derived. This staff works under the control of chief superintendents and inspectors;

2° Tests which serve as a basis for the imposition of penalties are carried out by the « rolling stock and traction laboratory », which also carries out tests for determining, for statistical purposes, the calorific value and the melting point of ash. Further, there is in the fuel supply department a small laboratory for rapid routine tests;

3° Tests are carried out to ascertain the percentages of ash and volatile matter, the nature of the coke produced, the fusibility of the ash, and the calorific power. In the case of briquettes friability tests are carried out. In certain cases the caking capacity is also ascertained;

4° The samples taken are always crushed by means of rollers, sub-divided by successive quartering, and passed through a sieve (type 35 : 144 openings per square centimetre (928 openings per square inch).

Ash : tests on 2 gr. (1.13 drams) in the gas furnace by the usual method.

Volatile matter : on 1 gr. (0.56 dram) with the Meker burner. « Muck » method.

Calorific power : with the Mahler bomb calorimeter.

Melting point of ash : use is made of the special Bigot type of gas furnace.

Friability of briquettes : the « drum method » is adopted.

5° As far as possible samples are taken by which the operations of the receiving staff can be checked.

IV.— Tenders are not invited publicly. Contracts are entered into with the collieries for periods varying according to the state of the stocks on the railway and the current prices of the various kinds of coal. During the present period of instability contracts are generally entered into for a period of three months, or in certain cases for longer periods subject to a revision clause. In the case of English fuel a certain number of collieries are invited to tender on clearly defined conditions, and orders are placed on the most favourable quotations.

V. — As regards the percentage of ash, the penalties or premiums are fixed at so much for each unit per cent above or below the standard percentage; the rate may vary, but it is generally more than 1 % of the cost of the coal.

As regards the percentage of moisture, in the case of moist fuel, washed small coal or briquettes, the company requires a guarantee of 4 %, any excess to be compensated for by payment in cash or in kind.

VI. — The Eastern Railway Company uses the following kinds of fuel for its locomotives : briquettes, screened coal, rough coal, various small coal, coke.

These different kinds of fuel (briquettes and coke excepted) are used in mixtures, the size of the coal and its freedom from ash varying, according to the nature of the service for which it is intended.

The mixtures are of three kinds :

1° Mixture A is used for the most difficult sections of the passenger and goods traffic. Half of this mixture consists of screened cannel coal or rich coal, the remainder consisting of rough coal and washed small coal, so that there shall be a considerable proportion of lumps and so that the percentage of ash shall not exceed 7 or 8 %.

Further, express train locomotives are given a quantity (varying according to the train) of screened large coal or rich quality to improve the efficiency of the boiler.

2° Mixture B is used for sections of passenger and goods traffic of average difficulty, consisting of a quarter of rich gas coal (or three-quarter rich), the rest consisting of rough coal or washed small coal; this mixture gives a percentage of ash between 8 and 10 %.

3° Mixture C is used for easy sections of goods traffic, and for station shunting operations, and does not contain any screened coal, but consists entirely of rough coal and raw washed small coal, the percentage of ash varying between 10 and 13 %.

VII. — The railway does not calculate the net cost of each class of fuel, but a single average cost for the whole of the fuel used.

VIII. — The mixing is done in the place in which the fuel is stored. The various kinds of fuel are unloaded in successive layers, and the mixing is effected by drawing off the fuel at the base of the stack at the spot where it is to be loaded on the tender.

IX. — 1° Each depot has a fuel siding so situated that the locomotives can be loaded up immediately on arrival at the depot;

2° The size of the stocks varies according to the storage accommodation available; as a rule an attempt is made to maintain a stock sufficient for from thirty to thirty-five days.

X. — The company only calculates the average monthly and yearly cost, on arrival of deliveries on the railway system, of all the kinds of fuel consumed by locomotives. It has no standardised form of statistics.

MIDI RAILWAY.

I. — Coal normally stocked :

1° Cardiff coal;
2° Durham coal;
3° Coal from the French mines of the Midi Railway Company.

Cardiff coal (briquettes, large coal and rough coal).

BRIQUETTES. — The kinds of coal used in the manufacture of briquettes shall be those most suitable for use on the grate; they shall be carefully washed or sorted so as to free them as far as possible from stones, shale or other foreign matter.

Only pitch, tar and the heavy oils derived from the distillation of tar shall be used as binding material, to the exclusion of all others.

The shape of the briquettes shall be parallelopiped; their weight shall be between 5 and 7 kgr. (11 and 15.5 lb.); they must possess all the qualities required for good combustion under ordinary service conditions, and give on burning a percentage of ash between 10 and 11 %. This ash must have a high melting point, and must not form clinkers adhering to the grate.

Their friability must be such as to allow of their handling and transport without breakage.

Their percentage of volatile matter must be between 17 and 22 %.

They must not contain more than 3 % of moisture.

LARGE COAL. — The large coal must as far as possible be free from shale, stones, or other foreign matter.

It must not contain more than 8 % of ash. It must be chosen from the half-rich qualities, that is to say those containing not less than 18 % or more than 25 % of volatile matter, and producing a well formed coke.

The nature of its ash (which must have a high melting point and must not form clinkers adhering to the grate), the percentage and nature of the volatile matter entering into its composition, and finally its calorific value, must be such that it shall be entirely satisfactory for the heating of locomotive boilers.

This coal must not contain more than 2 1/2 % of moisture.

ROUGH COAL. — Rough coal must, at the time of shipment from England, contain 50 % of large coal; it must be as free as possible from shale, stones or other foreign matter.

It must on burning produce between 10 and 11 % of ash and have between 18 and 25 % of volatile matter; it must give a well formed coke.

The nature of its ash (which must have a high melting point and must not form clinkers adhering to the grate), the percentage and nature of the volatile matter entering into its composition, and finally its calorific value, must be such that it shall consitute a fuel of high quality for the heating of locomotive boilers.

This coal must not contain more than 2 1/2 % of moisture.

Durham coal. — The rough coal must as far as possible be free from shale, stones or other foreign matter.

It must not contain more than 9 % of ash or more than 31 % of volatile matter, and must give a well-formed coke.

The nature of its ash (which must have a high melting point and must not give clinkers which adhere to the grate), the percentage and nature of the volatile matter entering into its composition, and its calorific power must be such that it constitutes a fuel of high quality for the heating of locomotive boilers.

The coal must not contain more than 2 1/2 % of moisture. Tests shall be carried out in respect of each day's deliveries to determine the percentage of moisture and the corresponding weight of water. This test shall be carried out with a special sample, broken up roughly, and protected against rain or evaporation. The weight of water thus ascertained shall be recorded in respect of each delivery. Ultimately, the total weight of water for all the deliveries together, divided by the total tonnage recorded at the weighing machine in respect of the deliveries received at the port of discharge, gives the average percentage of moisture. The excess of this figure over 2 1/2 %, applied to the total tonnage shipped as shown in the bills of lading, gives the excess weight of water which has to be deducted from the weight shewn in the bill of lading in respect of the final consignment at the time of payment for such consignment.

French coal. — ROUGH COAL. — The coal selected shall be the quality most suitable for use in locomotives.

It must as far as possible be free from shale, stones or other foreign matter.

The rough coal shall contain the six following sizes : 0/6, 6/12, 12/22, 22/35, 35/60 (washed) and 60 (sorted).

These sizes shall be obtained by means of screens consisting of iron sheets perforated with round holes.

The four lowest sizes (0/6, 6/12, 12/22 and 22/35) shall be delivered together, mixed in approximately equal parts, as a single class described as 0/35 mm. (0/1 3/8 inches).

The quantity of rough coal to be delivered monthly to the Midi Railway Company may vary, according to the quantities available at the colliery, in the following manner :

500 to 700 tons of 0/35 mm. (0/1 3/8 inches) coal;
550 to 350 tons of 35/60 (1 3/8/2 3/8 inches) coal;
1 050 1 050

The maximum percentage of ash is fixed at 13 %.

Large screened. — This coal shall be selected from the qualities most suitable for use in locomotive fireboxes. It shall as far as possible be free from shale, stones or other foreign matter.

It shall consist of the whole of that part of rough coal which will not pass through a rectangular screen of 0.030 × 0.030 m. (1 3/16 × 1 3/16 inches) mesh, or through a screen having round holes of corresponding size.

The maximum percentage of ash is fixed at 13 %.

Washed nuts. — This coal shall be selected from the qualities most suitable for use in locomotive fireboxes. It shall as far as possible be free from shale, stones, or other foreign matter.

It shall consist of the whole of that part of rough coal which will pass through a rectangular screen of 0.045 m. × 0.045 m. (1 25/32 × 1 25/32 inches) mesh, or through a screen having round holes of corresponding size, with the exception of such part of the coal as will pass through a screen of 0.025 m. × 0.025 m. (1 inch × 1 inch) mesh or a screen having round holes of corresponding size.

The maximum percentage of ash is fixed at 13 %. This coal must be washed.

Washed beans. — This coal shall be selected from the qualities most suitable for use in locomotives. It shall as far as possible be free from shale, stones or other foreign matter.

It shall consist of the whole of that part of rough coal which will pass through a rectangular screen of 0.030 m. ×0.030 m. (1 3/16 inches×1 3/16 inches) mesh, or a screen having round holes of corresponding size, with the exception of such part of the coal as will pass through a screen of 0.006 m. × 0.006 m. (1/4 inch × 1/4 inch) mesh, or through round holes of corresponding size.

The maximum percentage of ash is fixed at 13 %. This coal must be washed.

Washed peas. — Small coal shall be selected from the qualities most suitable for use in locomotive fireboxes. It shall as far as possible be free from shale stones or other foreign matter.

It shall consist of the whole of that part of rough coal which will pass through an iron sheet perforated with round holes 0.006 m. (1/4 inch.) in diameter.

The maximum percentage of ash is fixed at 13 %. This coal must be washed.

Briquettes. — The coal used in the manufacture of briquettes shall be chosen from the qualities most suitable for use on the grate; they shall be carefully washed or sorted so as to free them as far as possible from stones, shale or other foreign matter.

Pitch, tar and the heavy oils obtained by the distillation of tar may alone be used as binding material, to the exclusion of all others.

The briquettes shall be parallelopiped in shape, their weight shall not exceed 10 kgr. (22 lb.), and they must possess all the qualities required to give good combustion under ordinary service conditions. The maximum percentage of ash is fixed at 12 %; their friability must be such as to allow of their being handled and transported without breakage.

III. — 1° *Number and duties of employees.* — For checking of quality on delivery : four controllers and two workmen;

2° *In the laboratories.* — One second class inspector in charge of the laboratory, one head chemist, one assistant chemist, one distributor and one workman;

3° *Analyses and tests.* — The samples are taken by members of the laboratory staff in the various ports, and by the controllers in the French collieries.

The grinding of the samples is done by the workmen.

Combustion tests are carried out daily in respect of each shipload; the percentage of volatile matter is determined daily from a mixture composed of samples taken from each shipload; and the melting point of the ash is determined by testing a mixture of the various lots of ash obtained during the day.

The combustion tests on coal from the French collieries are carried out daily by the controllers and colliery officials independently.

4° *Methods adopted. — Tests for determining the percentage of moisture.* — The percentage of moisture and the corresponding weight of water are determined on each day's deliveries.

The testing is done on a special sample, broken up roughly and preserved carefully against rain and evaporation. The weight of water thus ascertained for each delivery shall be totalled. Subsequently, the total weight of water in all the deliveries, divided by the total of the weights shewn at the weighing machine for each delivery at the port of discharge, gives the average percentage of moisture. The excess of this figure above 3 % in the case of briquettes, or 2 1/2 % in the case of rich coal and rough coal, applied to the whole of the different shipments (weights specified in the bills of lading), gives the excess weight of water which has to be deducted from the weight stated in the bill of lading in respect of the final shipment when payment is made for the latter delivery.

The calculations relative to the percentage of moisture must be made for each class of coal, and the necessary adjustments for each class will be made on the account for the final delivery.

Tests for determining the percentage of ash. — The tests for ascertaining whether the different classes of coal satisfy the above conditions as regards their percentage of ash are made independently at the port of discharge in the following manner, by officials of the Midi Railway Company and representatives of the suppliers :

From the whole of the deliveries for each day (a day counting from midnight to midnight) there is taken a weight of about 1/2000th of the whole in the case of briquettes, and about 1/1000th in the case of large and rough coal, representing as nearly as possible the average composition of these deliveries. This constitutes the sample from which the quantities required for the combustion tests are taken.

The results obtained in the tests on the above sample are taken as applying to the whole of the coal delivered during the day.

The tests are carried out with dry coal.

Tests for determining the percentage of volatile matter. — The tests for determining the percentage of volatile matter and the nature of the coke are carried out on the Galloway method, as follows :

Loss at red heat. — In a porcelain crucible about 25 mm. (1 inch.) high, provided with a lid, 1 gr. (0.56 dram) of the sample is placed, in the form of powder. The crucible, surrounded by finely broken charcoal, is then placed in a second closed crucible made of fire-clay, the second crucible being about 120 mm. (4 3/4 inches high. The whole is heated for ten minutes in a furnace, which has previously been made red hot, at a temperature of from 900° to 1 000° C. (1 652° to 1 832° F.). After cooling, the smaller crucible is taken out, and the coke which has formed is weighed.

Loss at 100° C. (212° F.). — At the same time the percentage of moisture is ascertained by placing 1 gr. (0.56 dram) of the sample powder in a flat dish of large diameter. This is heated in a stove at 100° C. (212° F.) until there is no further loss of weight. The final loss of weight gives the moisture in the sample.

The percentage (V) of volatile matter in dry coal is given by the formula :

$$V = (a - h) \frac{100}{100 - h}$$

a being the total percentage loss of weight at red heat for undried powdered coal, and *h* the loss at 100° C. (212° F.) under the same conditions.

Tests for determining the friability of briquettes. — The tests for ascertaining whether the briquettes are satisfactory as regards friability are carried out in the following manner, and independently, by officials of the Midi Company and by the representative of the supplier.

From the total deliveries of the day a certain quantity of briquettes are taken and broken into pieces weighing about 500 gr. (1.10 lb.).

Of these pieces, 50 kgr. (110 lb.) is taken for the ordinary « drum test ».

IV. — Restricted public tenders, and contracts generally for one year at fixed prices.

V. — Prices are subject to increase or deduction according to the percentage of ash. Deductions are also made from the nominal weight of deliveries when the percentage of moisture is found to be excessive.

VII. — The French collieries situated on or near the railway system not being in a position to supply the whole of the fuel required, a certain quantity has to be imported at a price which at present is higher than that of the native coal.

VIII. — The different classes of coal on the wagons pass to the distributing platform, and are delivered to the engines in certain proportions depending on the trains which the engines will have to haul.

IX. — Stocks of fuel are kept at each depot. These stocks vary according to the needs and conditions of the locality, and are sufficient on the average for from 45 tot 50 days.

Paris-Orleans Railway.

II. — Solid fuel is divided, from the physical point of view, into four categories : small coal, rough coal of average size (cobbles), large coal and briquettes.

From the chemical point of view they are classified according to their percentage of ash and volatile matter and the melting point of the ash.

Percentage of ash. — This varies ordinarily within the following limits :

Washed small coal	7 to 13 %
Raw small coal. .	12 to 16 %
Rough coal . . .	9 to 14 %
Large coal . . .	7 to 12 %
Briquettes . . .	8 to 12 %

The above limits may be exceeded in certain exceptional cases where burning qualities of the coal and the melting point of the ash are such as to render the coal suitable for use in locomotives in spite of its high percentage of ash.

Percentage of volatile matter. — Varies between 15 and 35 %.

An attempt is made, by suitable mixing, to approximate as closely as possible to an average percentage in the neighbourhood of from 20 to 25 % in the fuel delivered on to locomotives.

Melting point of ash. — As far as possible the Company avoids the use of coal the ash produced by which has a low melting point, *i. e.,* lower than 1 200° C. (2 192° F.). In practice, the melting point of the ash produced by the coal used on the Paris-Orleans Railway varies between 1 200° and 1 450° C. (2 192° F. and 2 642° F.), but as far as possible we do not care to use fuel which gives an ash melting at below 1 300° C. (2 372° F.).

As regards liquid fuels, our railway has used fuel oil since 1920 on three engines adapted for the purpose. Different types of fuel oil of very varying characteristics have been experimented with. They have given practically identical results. At the present time the fuel oils which we use answer to the following general conditions :

The fuel oil must be free from sand or other solid matter capable of diminishing its utility or preventing or obstructing its free passage through the pumps, tubes, burners, etc., or likely to cause the deterioration of these parts of the mechanism.

Percentage of moisture. — This must not exceed 5 % of the weight.

Percentage of sulphur. — This must not exceed 6 % of the weight.

Percentage of ash. — This must not exceed 2 % of the weight.

Solid matter which may remain in suspension in the fuel oil when it has been heated, where necessary, to the degree of fluidity of raw colza oil at 15° C. (59° F.) must filter freely through a No. 70 brass sieve.

The ignition point, as ascertained by the Luchaire apparatus, must not be lower than 50° C. (122° F.).

The minimum calorific value must not be less than 9 800 calories per kilogram (17 640 British thermal units per lb.).

III. — At the ports the shipments of coal and briquettes are received by an inspector, assisted by a number of controllers; in the French collieries and briquette works the deliveries are inspected by controllers acting under the supervision of the central service at Paris.

As a general rule it is the control officials who take samples to be sent to the central laboratory at Paris to be used for ascertaining the percentages of ash and volatile matter. In certain cases they hand a portion of the sample to the supplier, and the Company agrees to accept, as representing the average percentage of ash, the average of the results obtained in its own laboratory and in that of the supplier.

The percentage of moisture in coal imported from abroad and in briquettes supplied by the works situated along the coast is ascertained by the control officials in the Company's laboratory at St. Nazaire or Bordeaux. In the case of French coal, the tests are carried out by employees of the Company in the laboratory at the colliery or works; in many cases premiums are granted under a clause in the contract according to the percentage of moisture.

The number of employees attached to the receiving service at present exceeds 50.

Apart from the tests for ascertaining the percentage of moisture, the various tests on deliveries of fuel are all carried out at Paris in the « rolling stock and traction laboratory », on samples taken in the manner described elsewhere in this report.

The tests which are regularly carried out in order to ascertain the quality of fuel are :

1° For all classes of fuel :

a) Percentage of ash;
b) Percentage of volatile matter.

2° For briquettes, in addition to the above tests friability is determined.

Finally, either before the contracts are signed, or while the deliveries are in progress, the following are ascertained with a view to ensuring that the quality remains constant :

Calorific power;
Melting point of ash;
Percentage of sulphur;
Composition of the ash.

Percentage of ash. — The sample received from the depots or from the receiving staff is reduced by three or four successive grindings to about 250 gr. (0.55 lb.) of powder.

The testing sample consists of about 3 gr. (1.69 drams), of this powder, which is accurately weighed in a platinum dish, and then burned by being heated gradually in a gas muffle up to a temperature of between 800 and 850° C. (1 472 and 1 562° F.).

Percentage of volatile matter. — About 4 gr. (2.26 drams) of the powder is weighed in a platinum crucible which has a lid with a chimney. This is then placed in a gas muffle and heated gradually up to a temperature of from 1 050 to 1 100° C. (1 922 to 2 012° F.).

Friability. — Use is made of the naval type of cylinder with three inner blades fixed at an angle of 120°. The cylinder used by the Paris-Orleans Company is worked by electricity. We have thus been able to obtain absolute regularity of speed (fifty revolutions in two minutes).

Calorific power. — Ascertained by means of the Mahler bomb calorimeter by burning about 1 gr. (0.56 dram) of the powder in an atmosphere of pure oxygen at a pressure of 25 kgr. (55 lb.).

Melting point of ash. — Use is made of a fireclay head with a diametrical division. In one compartment is placed 200 milligrammes (0.11 dram) of powder ground up with ash, and in the second compartment 200 milligrammes (0.11 dram) of powder with a Seger cone, the melting point of which is known. The whole is heated in a coke oven, with which it is possible to melt the Seger cone at 1 500° (2 732° F.).

Sulphur. — The fuel is burned and the sulphur is completely oxidised by means of a Mahler bomb containing oxygen at a pressure of 10 kgr. (142.23 lb. per square inch).

Composition of ash. — The method is the same as that adopted for the complete analysis of silicates and clays.

Finally, the quality of the fuel received is checked by practical tests carried out by drivers on locomotives of the ordinary service.

IV. — Purchases are made on terms mutually agreed for periods varying generally between three months and one year.

V. — The price is generally fixed for fuel having the percentage of ash and of moisture specified in the contract; premiums and penalties are applied if the average percentage of ash obtained in the laboratory tests is lower or higher than the specified figure, and a deduction is made from the invoiced weight equal to any excess of moisture as ascertained in the Company's laboratory. The average percentages of ash and moisture are ascertained in respect of the total deliveries for the month in the case of supplies arriving by rail or inland waterway, and in respect of each delivery in the case of supplies arriving by sea.

In general the penalties amount to from one-and-a-half times to twice as much as the premiums, and are equal to about 2 % of the price of the coal for each unit per cent of excess ash.

VII. — Our statistics do not enable us to supply particulars in the desired form, *i. e.*, grouping the locomotives according to their consumption per square metre of grate surface per hour.

We have, however, given what details we possess in respect of the year 1922 for the railway as a whole.

VIII. — As a general rule, the fuel of various classes and from various sources is stacked separately, and mixed in the required proportions when it is loaded on the tender. When, however, conditions permit, it may be mixed immediately on arrival at the coal depot.

The nature of the mixtures adopted is extremely variable, depending on the one hand on the qualities of coal available, and on the other hand on the actual work to be executed by the different engines. In all cases we endeavour to obtain mixtures having a percentage of volatile matter between 18 and 25 %, and we avoid as far as possible using coal which gives an ash melting at below 1 200° C. (2 192° F.), or coal which produces clinkers which adhere to the grate.

The proportions of the better class of fuel (large coal and briquettes) are much higher for fast trains than for slow trains, goods trains and shunting engines.

IX. — In order to allow on the one hand for irregular deliveries (particularly in the case of coal depots supplied exclusively with imported coal), and on the other hand for the consequences of trade or political complications, we endeavour to maintain at each coal depot a normal two months' stock of small and rough coal, one month's stock of large coal, and three months' stock of briquettes (the latter in principle not being considered suitable for use until one month after manufacture).

We endeavour as far as possible to use French coal in coal depots situated near to the collieries, with a view to minimising the cost of transport; in the same way, imported coal is particularly used in depots in the neighbourhood of the ports of discharge (Bordeaux, St. Nazaire, Lorient).

The storage of coal in our depots is governed by regulations which specify under what conditions it is to be stacked, the periods within which the stocks are to be renewed, and the precautions to be taken to avoid heating.

We have, further, two supplementary stores at Bordeaux and St. Nazaire. They are used to hold temporary stocks of fuel :

1° in case of insufficiency of rolling stock for transporting fuel to the coal depots;

2° when the depot storage accommodation is full up.

This arrangement makes it possible to unload shipments without delay, thus avoiding the payment of demurrage charges.

X. — We have no fixed list of prices, but when we have several offers of different classes of coal of such quality that they can be substituted one for the other, we carry out practical engine tests and compare the net costs, taking into consideration calorific power, the quantities of water vaporised per kilogram of fuel, the consumption per ton-kilometre, and the cost of transport, storage and handling. In this case also the cost of transport is calculated on the number of ton-kilometres, and the costs of storage and handling are estimated on the figures for the railway as a whole.

At the present time, when fuel is scarce and the terms on which it can be obtained are very variable, contracts are only entered into for short periods, and the quantities involved are not always sufficiently large to justify going to the length of making the above comparison.

PARIS-LYONS-MEDITERRANEAN RAILWAY.

I. — We have no standing regulations with regard to the supply of fuel for traction purposes.

We obtain our supplies as far as possible from French collieries, with which we deal on terms mutually agreed in each case, the conditions laid down by us depending on the qualities of coal to be supplied.

For the remainder of our requirements we have to resort to imported coal, and in such cases we enter into contracts on the terms considered appropriate to each individual case.

We do not use liquid fuel on locomotives.

III. — Acceptance of deliveries is taken at the coal depots nearest to the place whence the coal is derived.

In this connection the depots are grouped and controlled from five centres : Villeneuve-St.-Georges, Chasse, Brassac, Courbessac (near to Nimes) and Marseilles.

1° and 2° Each of the control centres is placed under a fuel inspector, under whom there is a staff of, on the average, ten employees, occupied in the preparation and analysis of samples. This inspector has the use of a laboratory.

3° and 4° In principle an average sample of each class of fuel is taken daily at each receiving centre.

These samples, after being ground and dried, are sent to the laboratory to be analysed.

Determination of percentage of humidity. — This test is carried out at the place to which the coal is delivered. 500 gr. (1.10 lb.) of the sample are spread in a very thin layer on a tray which is placed on a shelf in a room heated to 18 or 20° C. (64.4 or 68° F.) and left there for at least a whole night. In order to know when the coal is sufficiently dry, the tray and its contents are weighed at intervals until it is found that there is no further loss of weight. From the loss of weight it is possible to calculate the percentage of moisture.

Determination of percentage of ash. — This is done in the laboratory, using the dried samples supplied by the receiving depots. These samples are evenly ground by means of rollers. They are then passed through a very fine sieve (100 holes to the square centimetre [645 holes per square inch]); anything remaining on the sieve is then further ground until all will pass through the sieve. Five grammes (2.82 drams) of the powder are then weighed (exact to 1 milligramme [0.00056 dram]), in a fireproof dish, the weight of which is known; this is then placed carefully in the red hot to white hot muffle of a reverberatory furnace; this temperature is maintained for at least two hours to ensure complete combustion; the dish is then re-weighed, and from the loss of weight the percentage of ash can be calculated.

Note is taken also of the colour of the ash, as this gives some indication as to its nature and fusibility.

Determination of melting point of ash. — The ash to be tested is compressed into small discs without the addition of any extraneous matter; these discs are placed, together with two other standard discs, on a fireclay tray and put into a furnace heated to about 1 300° C. (2 372° F.).

The standard discs are composed : one of ash from coal from Mariemont

(Belgium); one of ash from coal from La Chazotte (Loire).

These tests will have been satisfactory if the Mariemont disc has preserved its shape and the sharpness of its edges; and if the La Chazotte disc has assumed a semi-spherical form with an obviously swollen appearance.

Classification of ash as regards its fusibility is made on the results of these tests, and is indicated by numbers from 1 to 5, as follows :

Class 1 : the disc preserves its shape and the sharpness of its edges;

Class 2 : the disc preserves its shape but swells slightly, and the edges begin to show signs of fusion;

Class 3 : the disc becomes almost entirely transformed into a kind of thick paste, and assumes a semi-spherical shape;

Class 4 : the disc, which is completely vitrified, has begun to « run », retaining however a certain shape;

Class 5 : the disc melts completely and spreads over the tray.

Coal which gives an ash coming under Class 5 is unsuitable for use in locomotives.

Determination of percentage of volatile matter. — Use is made of the same dry, fine powder, part of which has already been used for ascertaining the percentage of ash. An exact weight of 5 gr. (2.82 drams) is placed in a fireclay crucible, the latter having a lid with a hole in the centre for the escape of the volatile matter. This is placed carefully in the almost white-hot muffle of a reverberatory furnace. In the case of coal which has a high percentage of volatile matter, care must be taken to leave the crucible for a moment on the edge of the muffle until the powder ignites and the thickest of the smoke has been given off; unless this is done, the violent escape of the gases impairs the accuracy of the experiment. At the end of ten minutes (or at most fifteen minutes in the case of the most gaseous coal) the operation is complete; the crucible is re-weighed and from the difference of weight can be calculated the percentage of volatile matter.

5° A duplicate sample is kept for testing in case of dispute. Further, special samples for checking are taken from time to time from the depot stocks. The results obtained in tests with these samples are compared with those obtained at the time of delivery.

IV. — Our purchases are effected at prices mutually agreed with the principal French collieries and with certain foreign collieries. There are certain limited contracts with other suppliers of foreign coal.

Our contracts run as a rule for one year.

As far as possible we deal at fixed prices, but under present-day conditions we have been compelled to agree to revision of the basic prices in certain cases in view of variation in the cost of labour.

V. — As a rule the price paid to the supplier depends on the percentages of moisture and ash as ascertained at the time of delivery.

As regards the percentage of moisture, the basic price is generally fixed in respect of coal free from moisture, and the weight of water ascertained on delivery is deducted from the nominal weight of the coal.

As regards the percentage of ash, the price is based on a fixed percentage, or a percentage lying between certain fixed limits. If the percentage is found to be lower than the fixed limit, the price is increased; in the opposite case the price is reduced. The scales of premiums and penalties vary according to the nature of the contracts; the rate is generally from 2 to 2 1/2 % *ad valorem* for every unit per cent by which the actual percentage differs from the standard percentage.

VII. — The net cost of fuel for a given series of engines is determined on the one hand by the average cost of the fuel consumed by the engines of the series, or (which amounts to the same thing) by the ratio between the consumption of each class of fuel and the total consumption; and on the other hand by the quantity of fuel consumed per kilometre or per 100 ton-kilometres.

We determine for each series of engines, and according to the nature of the work to be performed by them, the class of fuel to be used and the proportion in which the most expensive varieties may be used. It follows, therefore, that the average cost of the fuel consumed varies from one series of engines to another.

As regards the quantity of fuel consumed, this varies from one series of engines to another, not only because the various types of engines differ in power but also — and particularly — because the work which they have to perform is not identical.

VIII. — The mixing of different classes of fuel is done either in depots specially provided for the purpose, or at the spot where the fuel is to be stacked, or at the time it is loaded on the tender.

In our mechanical mixing installations the coal is unloaded into hoppers (one for each kind of coal) below which there is a horizontally rotating distributor. The coal falls on to a long revolving band on which it forms a thin layer of mixture. On arriving at the end of the band the mixture thus obtained is carried by a bucket-chain into a hopper to be loaded thence into wagons.

When the mixing takes place at the spot where the fuel is to be stacked, one quality of coal is first spread in an even layer on the ground, then on the top of this first layer a second one of another quality of coal is spread, the thickness of the layers depending on the proportions required in the mixture; the building of the stack is then continued by successive layers.

By taking out the coal with a shovel at the foot of the stack, the desired mixture is obtained.

When the mixing is done at the time the coal is loaded on the tender, rows of baskets are arranged on the loading platform, these baskets being filled alternately with each of two kinds of coal, when the mixture is to consist of the two kinds in equal proportions; or one basket with one kind of coal and the next two with the other kind, if the ratio of the two kinds in the mixture is to be 2 : 1; and so on. The baskets are emptied into the tender in the order in which they have been arranged on the ground.

IX. — In principle fuel is stored as near as possible in the place at which it is delivered. Our purchases are so arranged that in normal times our stocks are sufficient for about two months.

X. — 1° We do not work out the net cost of consumption of fuel per kilometre and per 100 ton-kilometres *for each type of locomotive.* Every month, however, with the aid of information supplied by the statistical department, we calculate the average consumption *for the railway as a whole.* From this it is easy to calculate, according to the average cost of the coal, the net cost per kilometre and per 100 ton-kilometres.

CHALOSSE AND BÉARN STEAM TRAMWAYS.

I. — The Midi Railway Company supplies the fuel required by these tramways.

VIII. — The fuel is used without previous preparation or mixing.

IX. — The coal depots are situated at :

Dax St. Pierre (engine depot) .	120 t.
Amou (junction)	60 t.
Aire-sur-l'Adour (terminus) . .	20 t.
Peyrehorade (terminus). . . .	20 t.
Monthly consumption	220 t.

RAILWAYS OF THE TARN DÉPARTEMENT.

I. — There are no standing regulations with regard to fuel.

III. — There is no special receiving service on these lines.

IV. — Purchases are not made on contracts; prices follow current market rates.

V. — The cost varies as between coal and briquettes.

VIII. — Fuel is used in the condition in which it is received from the colliery.

IX. — The reserve stock is sufficient for one month.

RAILWAYS OF THE LANDES.

I. — The Midi Company supplies the fuel required by these lines.

VIII. — The following mixture is used: three-quarters rough coal, one-quarter English large coal.

The driver prepares his own mixture.

IX. — At each terminus (the lines have dead-ends) there is a stock of fuel generally amounting to from 20 to 30 tons.

RAILWAYS OF THE EASTERN PYRENEES.

III. — There is no special fuel reception service on these lines.

IV. — Fuel is bought at prices fixed separately in each individual case.

V. Fuel is paid for at the fixed agreed price.

VI. The kinds of fuel used are washed small coal and briquettes.

IX. There are no standing regulations with regard to the storage of fuel.

b) **Algeria and Tunis.**

ALGERIAN STATE RAILWAYS.

I. — There are standing regulations regarding the supply of briquettes, and laying down the principle characteristics which they must possess. This railway system has not adopted regulations with regard to coal, which class of fuel it did not, in fact, use before the war.

Extracts from the standing regulations regarding briquettes :

Description of briquettes. — The briquettes shall be manufactured from small coal mixed with dry pitch obtained by the distillation of coal tar.

They shall have the shape of a rectangular parallelopiped, and shall bear an identification mark showing the place of origin.

They shall be as uniform as possible in weight, so that the average weight is constant; this average weight shall be specified by the supplier in his tender.

Quality of material used in the manufacture of briquettes. — The small coal used in the manufacture of briquettes shall be of the so-called half-rich quality which, on combustion in a closed vessel, gives a hard partially fused coke.

The coal shall be of recent extraction, free from sulphur, shale, pyrites or other foreign matter.

English coal, other than Cardiff and Newport coal, shall not be used in the manufacture of briquettes; also, coal containing less than 11 % of volatile matter and cannel coal, from whatever source, shall be excluded.

Quality of briquettes. — GENERAL CONDITIONS. — The briquettes shall be hard, sound, evenly grained and practically odourless.

FRIABILITY. — The briquettes shall normally possess a minimum friability of 55/100.

PERCENTAGE OF ASH. — The briquettes shall not normally give a percentage of ash, after complete combustion, higher than 9 % of their weight.

The ash when heated by means of a gas blowpipe must be fire-resisting.

PERCENTAGE OF VOLATILE MATTER. — The briquettes shall not, on distillation in a closed vessel, show a loss of volatile matter of less than 17 % or more than 22 % of their weight, moisture deducted.

PERCENTAGE OF MOISTURE. — The briquettes shall as far as possible be free from moisture, and shall not ordinarily be weighed and delivered until at least five days after the day on which they are made.

BEHAVIOUR OF BRIQUETTES IN LOCOMOTIVE FIREBOX. — The briquettes should light readily and burn with a bright, clear flame, producing only a light grey smoke; they must not produce clinkers adhering to the grate; they must not cake together in masses, nor fall to pieces before combustion is complete.

II. — BRIQUETTES. — Composition : 8 % pitch and 92 % washed small coal. Average weight of briquettes : 7 kgr. (15.4 lb.).

ENGLISH COAL. — Large screened.

KENAZDA COAL (from mine in the south of the Oran Département (Algeria) : large coal and rough coal.

III. — *Reception of briquettes.* — TAKING OF SAMPLES. — The samples are taken from each delivery in the following manner :

One briquette is taken from each wagon-load and broken into two pieces; one of these pieces is kept as a sample.

From the half-briquettes thus collected, at least 110 sections are sawn, each weighing about 500 gr. (1.10 lb.) and the total quantity weighing about 60 kgr. (132 lb.) This total sample is used for the friability test.

The pieces, or remains of pieces, of briquettes left over from the friability test, combined with the remainder of the sample taken, are used for laboratory tests, being first of all ground down to give from 500 to 600 gr. (1.10 to 1.32 lb.) of powder which will pass through a No. 60 sieve.

Out of this sample powder, three vessels are filled, each containing about 50 gr. (0.11 lb.). These three vessels are numbered and closed, being sealed with the seal of the State Railway and of the supplier. One of them is used for a test carried out by the railway in one of their laboratories; the supplier must be notified of the date of the test so that either he or his representative may be present. The second is handed to the supplier, and the third is retained by the railway for use in case the first sample is damaged or lost.

BRIQUETTE TESTS. — The samples taken independently by the railway and the supplier from each delivery are submitted to the following tests :

1° **Friability test.** — The pieces to be used in the cohesion test are tested by means of the naval type of apparatus described below :

The apparatus consists of a cylinder of sheet-iron 10 mm. (3/8 inch) thick, closed by two flat end-pieces also made of sheet-iron (each end-piece having a central pin at the axis of the cylinder) and resting on two supports by means of the two pins.

The internal diameter of this cylinder is 90 cm. (2 ft. 11 1/2 in.), and the distance between the two ends is 1 metre (3 ft. 3 3/8 in.). It has three sheet-iron blades fixed on the inner surface, arranged radially, with an angle of 120° between each. The blades are the same length as the inside length of the cylinder and 20 cm. (7 7/8 inches) wide. An opening which can be closed by means of a slide allows of the introduction of the substance to be tested.

About 50 kgr. (110 lb.) of the pieces

of briquette, prepared as described above, are placed in the cylinder, which is then made to revolve 50 times on its own axis in the space of about 2 minutes. The contents are then emptied out on to a horizontal grate made of bars 1 cm. (13/32 inch) thick, so arranged as to give openings 3 cm. (1 3/16 inch) square. The pieces remaining on the grate are then collected. The friability is given by the ratio between the weight of the pieces remaining on the grate and the total weigh tested.

This figure is taken as applying to the whole of the deliveries from which the testing samples have been derived.

2° **Laboratory tests.** — A portion of the sample sent to the laboratory is first of all dried at 100° C. (212° F.), and then the percentages of ash and volatile matter are determined by the usual methods. The percentages thus obtained are taken as applying to the whole of the deliveries from which the samples have been derived.

The supplier is not entitled to dispute the results of the laboratory tests, although he or his representative is entitled to be present during the tests, his absence, however, does not necessitate the postponement of the operation.

CONDITIONS RELATIVE TO ACCEPTANCE OR REJECTION OF DELIVERIES. — A delivery is accepted if all the stipulated conditions are complied with.

If the percentage of ash is found on testing to be less than 9 % and the percentage of volatile matter at least 17 %, the price per ton of the delivery in question is increased by 4/1000ths for each 1/100th per cent of ash below 9 %.

If the degree of friability is found on testing to be less than 55/100, the price per ton of the delivery in question is reduced by 15 centimes in respect of each hundredth below 55/100 down to 45/100 inclusive. For each hundredth below 45/100 the rate of reduction is increased from 15 to 20 centimes.

If the percentage of ash is found on testing to be higher than 9 %, the price per ton of the delivery in question is reduced by 5/1 000ths for each hundredth per cent above 9 %.

If the degree of friability of a consignment is below 40/100, or if the percentage of ash exceeds 12 %, or if the percentage of volatile matter exceeds 22 % or is below 17 %, the consignment can be refused; if it is accepted, it can only be at a reduced price.

FUSION TEST AND WORKING TEST. — The ash is tested to ascertain the fusibility at the temperature indicated by the No. 14 Seger cone (about 1 400° C. [2 552° F]).

If the sample disc when submitted to this temperature preserves its form, or while losing its form does not actually melt, the delivery can be accepted.

If the sample disc loses its form and spreads in the laboratory test, the briquettes are tested in the firebox of a locomotive.

If during the course of this test the briquettes do not produce clinkers adhering to the grate, or of such a nature as to impair combustion, they may be accepted; if they do not pass this test satisfactorily, they can only be accepted subject to a reduction in price.

1° *Briquettes and English coal.* — One official at each port of discharge. Six officials in all (Arzew-Mostaganem-Bougie-Philippeville and Bône). These employees are detailed for the work at the time of each arrival by sea, and are selected from among the personnel of the traction service, being employees who have sufficient elementary instruction to enable them to carry out the work (chief inspector or driver, inspector, or workman, according to circumstances).

Kenadza coal. — A railway representative is permanently stationed at the pit.

2° One laboratory at Perregaux for the analysis of coal received at the ports on the west of the railway system (Arzew and Mostaganem) and of coal from the Kenadza mine.

One laboratory at Sidi-Mabrouk (Constantine) for the analysis of coal received via the Algerian ports and the ports east of the railway (Bougie-Philippeville and Bône).

3° Analysis at the laboratory, and running tests (evaporation tests, etc.).

4° *a*) Analysis at the laboratory of raw dried samples in order to determine the percentage of moisture, of volatile matter, of ash and of fixed carbon, and the calorific value.

b) Running tests to ascertain the efficiency of combustion, the nature of the ash, and the quantity of water vaporised per kilogram of coal.

5° No special methods. The analyses and running tests are considered sufficient to determine the quality of the fuel.

IV. — Contracts are placed on tenders received in open competition. Before the war the duration of contracts was one year. The period at present is six months, in view of the instability of prices and rates of exchange.

V. — Since the war suppliers have not, as in the past, formally guaranteed a certain percentage of ash and of volatile matter. The prices agreed are therefore fixed prices.

VII. — No comparison is possible, as there is only one type of locomotive in use (type C) on these railways.

VIII. — The fuel used does not in general require any preparation. In the case, however, of certain long distance fast trains, a certain quantity of briquettes is broken up on the tender before departure.

Cardiff or Kenadza coal is used, mixed with briquettes preferably in the case of mixed trains and goods trains, in the proportion of 20 to 40 %. The fuel is loaded on the tender in these proportions, and the mixing is done en route by the stoker.

IX. — 1° Fuel stocks are kept at the various fuel and rolling stock depots. In order to minimise the transport of fuel, the largest stocks are held at the depots nearest to the seaports.

2° The size of stocks depends on the importance of the depots.

X. — 1° There are no special tables showing the net cost of fuel consumed.

The rolling stock and traction service supervises closely all questions relating to the consumption of fuel by locomotives.

The various sections of the railway keep a record in the case of each depot of the monthly average consumption per 100 ton-kilometres for each engine, and in cases where the consumption exceeds the average, inquiry is made into the circumstances.

A statement showing the figures for each locomotive and the average consumption per 100 ton-kilometres per series of locomotives per depot, is sent monthly to the headquarters of the traction service, which is thus in a position to ascertain whether the fuel is being used to the best advantage.

2° We have no information enabling us to answer this question.

Algerian Railways of the P. L. M. Company.

I. — The special conditions laid down with regard to the fuel used by the P. L. M. railways of France also apply in the case of the P. L. M. Algerian Railways. The latter, in fact, derive the greater part of their fuel supply from the stocks held by the P. L. M. in France.

Tunisian Railway Company.

I. — Since the war we have used on our locomotives « Anchor » briquettes made of Cardiff small coal in the briquette works erected with our assistance at Bizerte.

The process of manufacture, which is supervised by our representatives, is described below.

As regards liquid fuel, our consumption is extremely low and only in the experimental stage. In view of the small quantities consumed it has not been considered necessary to draw up special regulations.

II. — The briquettes used possess the following characteristics :

Moisture	1.0 to 4.5 %
Volatile matter	15.0 to 17.0 %
Ash	10.5 to 12.0 %
Fixed carbon	68.5 to 71.5 %

The mazout (oil) partially utilised for heating certain of our locomotives has the following characteristics :

Density at 15° C. (59° F.)	0.946 to 0.960
Ignition point	85° C. (185° F.)
Temperature of combustion. . . .	130° C. (266° F.)
Barbey fluidity :	
at 35° C. (95° F)	22/26
at 50° C. (122° F.).	55/60
at 100° C. (212° F.)	460/500
Sulphur	3 to 3.5 %

III. — 1° and 2° As soon as the briquettes are made they are loaded on wagons and weighed at the weighing machine, the operation being checked independently by a representative of the briquette works and by our railway representative. From every consignment of 500 tons, a quantity of briquettes weighing about 50 kgr. (110 lb.) is taken; this quantity is used for preparing an average sample weighing 2 kgr. (4.40 lb.), which is divided between four 1/2 kgr. (1.10 lb.) bottles two of the samples are sealed and sent to our laboratory for analysis; the remaining two, also sealed in the presence of the supplier's representative, are kept for analysis in case of dispute. The reception official then dispatches the wagons to the localities indicated to him by the fuel department of the traction service; he is the only official connected with the reception of fuel supplies.

Our laboratory is equipped for the determination of the principal characteristics of solid and liquid fuel, as described below; at the present time we do not ascertain the calorific power of the fuel, but we are making preparations for providing the necessary installation for this purpose.

3° The following analysis and tests are carried out :

Solid fuel :

Determination of percentage of moisture;
Determination of percentage of volatile matter;
Determination of percentage of ash;
Determination of percentage of fixed carbon (by difference);
Friability test.

Liquid fuel (mazout) :

Determination of density;
Determination of ignition point;
Determination of temperature of combustion;
Determination of Barbey fluidity;
Determination of quantity of sulphur.

4° We adopt the usual methods for the testing and analysis of the various kinds of fuel.

Analysis of solid fuel (briquettes).

Percentage of moisture. — From 25 to 30 gr. (14.1 drams to 1 oz. 1 dram) of powdered briquette are placed in a weighed porcelain crucible with a lid; the whole is placed in an oven and kept at a temperature of from 100 to 105° C. (212 to 221° F.) for three hours; from the resulting loss of weight the percentage of moisture is calculated.

Percentage of volatile matter. — 1 gr. (0.56 dram) of the powder is weighed in a platinum crucible (with lid) of known weight. The crucible is then placed on a triangle of platinum wire, in such a way that the bottom of the crucible is 3 cm. (1 3/16 inches) above an alcohol burner, the flame of which must be 18 cm. (7 3/32 inches) high and completely surround the crucible. The crucible is thus made red-hot, and the volatile matter burns around the lid, which is kept firmly in position by the weight of a steel rod resting vertically on the top of the lid. The heating is continued for three minutes after the volatile matter has ceased to burn. The crucible is then allowed to cool, after which it is weighed to ascertain the loss of weight, and from this, and the percentage of moisture previously ascertained, it is possible to calculate the percentage of volatile matter.

Percentage of ash. — About 2 gr. (1.13 drams) of the powdered fuel is weighed in a platinum dish, which is then placed in a muffle which is then lighted and the dish there at full red heat for from two to three hours. After cooling, the residue is weighed, and the percentage calculated. Two samples are generally tested, and the average of the two results is taken.

Percentage of fixed carbon. — The percentage of fixed carbon is obtained by subtraction of the other percentages from 100.

Determination of the degree of friability. — In order to ascertain the degree of friability, 100 pieces of briquette, weighing about 500 gr. (1.10 lb.) each, are taken from each delivery, but so that the total weight is exactly 50 kgr. (110 lb.) and represents as near as possible the average quality of the delivery.

These pieces are carefully placed inside a hollow sheet-iron cylinder, 910 mm. (2 ft. 11 7/8 in.) in diameter and 957 mm. (3 ft. 1 21/32 in.) long, which can be made to revolve on its own axis by means of a handle, and on the inner surface of which are fixed three longitudinal blades 200 mm. (7 7/8 inches) wide and the same length as the cylinder.

The cylinder is then made to revolve for two minutes at the rate of 25 revolutions per minute, after which the contents are emptied out on to a screen with square holes of 3 cm. (1 3/16 inches) side, and the quantity which will not pass through the screen is weighed.

The ratio between this weight and the total weight of briquettes tested (50 kgr.) gives the degree of friability.

Analysis of liquid fuel (mazout).

Determination of density. — This is done by means of the densimeter at 15° C. (59° F.).

Ignition point. — The Luchaire apparatus is used to determine the ignition point.

Barbey fluidity. — Determined by the Barbey ixometer at 35, 50 and 100° C. (95, 122 and 212° F.).

Percentage of sulphur. — From 1/2 gr. to 1 1/2 gr. (0.28 dram to 0.85 dram) of oil is weighed in a 100 cm³ (6.10 cubic inches) porcelain crucible; 5 cm³ (0.31 cubic inch) of concentrated nitric acid saturated with bromine are then added, after which the crucible is covered and heated in a water-bath for from 2 to 3 hours. It is then allowed to cool, and from 10 to 12 gr. (from 5.64 to 6.77 drams) of anhydrous carbonate of sodium are added little by little to the contents. The pasty mass which results is spread over the inner surface of the crucible, dried on the water-bath, and calcined by means of a small flame applied to all parts of the crucible. The crucible and its contents are then again gently ignited. The contents are then dissolved in 150 cm³ (9.15 cubic inches) of water which has been rendered acid by the addition of HCl in slight excess, and a precipitate is obtained by means of 10 cm³ (0.61 cubic inch) of $BaCl^2$. This is left standing for a whole night, then it is filtered, dried and weighed.

Determination of inorganic acidity. — This is done by means of a solution titrated with sodium hydroxide in the presence of phenolphtalein.

5° When complaints are lodged by drivers in the course of their ordinary work, we take samples of the fuel on the locomotives, and after analysis a claim is made against the supplier if this course appears justified.

III. — Apart from locomotives of Series 681, which utilise mixed fuel (briquettes and mazout, the latter being used as an auxiliary fuel for difficult sections of line), all the other series of locomotives use the same fuel (briquettes); the factors affecting the figures of cost price are : the type of locomotive, the load hauled, the gradient of the line, the speed of trains, etc.

In the case of locomotives of Series 681, the consumption per ton-kilometre is less, both as regards weight and cost, than in the case of the similar locomotives of series 551; it would therefore appear desirable to use mazout, at any rate on the basis of the figures for 1922.

During 1923 experiments were carried out with English rough coal, consisting of a mixture of large and of small coal, plus a proportion of briquettes. As compared with briquettes only, the following results were obtained :

Briquettes only. . .	Consumption per ton-kilometre (per English ton-mile) .	0 kgr. 03895 (0.1404 lb.)
	Price : 0 fr. 007961.	
Briquettes 72.7 % Rough coal 27.3 %	Consumption per ton-kilometre (per English ton-mile) .	0 kgr. 04158 (0.1499 lb.).
	Price : 0 fr. 009037.	
	(mixture found necessary to obtain satisfactory results).	

We have not found it economical to use rough coal, taking into consideration present prices (purchase price of the coal, cost of transport and cost of handling included).

VIII. — The briquettes weigh approximately from 9 to 10 kgr. (19.8 to 22 lb.); it is necessary to break them up; this is done on the tender by the stoker as required, the arrangement and capacity of the bunkers and the size of the supply carried not allowing of this being done before departure.

On locomotives with a separate tender the briquettes are broken on the tender prior to departure.

When coal of different kinds is used it is not possible to make the mixture before departure in the case of tank-engines; as thorough a mixture as possible is made in the case of tender-locomotives.

The above pre-supposes the use of fuel which gives a satisfactory evaporation; if this is not the case, the inferior fuel is used on the easier stretches of line, mixed when and as necessary with briquettes.

Liquid fuel is used in the form in which it is supplied; in case of necessity use can be made of a jet of steam to render the oil more fluid.

IX. — In principle, locomotives derive their supplies of fuel from the depots nearest to the point of departure, so as to avoid unnecessary transport; but certain types of locomotives, particularly tank-locomotives, are obliged to take in supplies at most of the depots during the journey.

The quantities purchased depend on the monthly consumption of the fuel depots and sheds; the deliveries being more or less regular, each of these centres receives the quantity necessary to enable it to keep a stock sufficient for about three months.

X. — As we only use one class of solid fuel, we do not keep tables of cost for different classes of fuel.

c) Colonies and protectorates.

ABYSSINIA.

FRANCO-ETHIOPIAN RAILWAY, DJIBOUTI TO ADDIS-ABEBA.

VIII. — A single quality is used, so that no mixing is necessary.

If the quality of the fuel is doubtful, or the fuel does not give entire satisfaction, a mixture is made at the time of loading on the tender.

General Administration of Railways and Public Works.

ASIA MINOR.

DAMASCUS-HAMAH RAILWAY AND EXTENSIONS.

III. — 2° Laboratory tests are carried out for this railway by the « Faculté française et de Pharmacie », Beyrout. The samples of coal supplied for testing purposes weigh 10 kgr. (22 lb.). The fee per test is 40 francs.

5° Practical tests are carried out on a locomotive on an ordinary sheduled return journey, to determine :

the quantity of coal consumed per kilometre;

the quantity of coal consumed per ton-kilometre;

the percentage of loss (ash, and smoke-box);

water vaporised per kgr. of coal;
calorific value utilised in practice.

These practical data are compared with those obtained in previous tests and with the results of the laboratory analyses.

IV. — Fuel is purchased from suppliers whose names are entered on a list kept by the Damascus-Hamah Company. These suppliers are resident at Beyrout and Tripoli for the most part, or in some cases even in France and abroad.

V. — Orders are placed on the most favourable quotations received; the cost of transport is included in the price quoted.

There are no scales of prices, as the various kinds of coal purchased are generally obtained from the same source, and their characteristics vary very little from one delivery to another.

VII. — We always use the same coal for the same section of the railway; thus:

Standard gauge line : Cardiff large coal;

Narrow gauge rack or adhesion railway : Cardiff briquettes (trade mark, « Anchor » or « Crown »).

Briquettes are used for preference on narrow gauge lines, as our tank-engines can only carry the small quantity of 3 1/2 tons, the amount required for the return journey on their sections of line. It would be impossible for them to carry sufficient large coal for the double journey.

In general, in view of the good quality of the coal used :

1° engines can carry the whole of the fuel necessary for the whole journey, thus avoiding the necessity for loading at intermediate stations, and thereby reducing unnecessary transport of fuel over the railway system;

2° trains of maximum size can be run over steep and long inclines without difficulty or loss of time, and with a minimum consumption of fuel;

3° it is possible to obtain a regular production of steam without variation of pressure prejudicial to the fireboxes. (The latter, incidentally, are sufficiently troubled by the highly calcareous nature of the feed-water obtainable in the locality).

IX. — Engines from the Aleppo depot do the return journey, Aleppo-Homs. Engines from the Rayak depot do the return journey, Rayak-Homs.

They take in their supply of fuel at Homs, thus rendering unnecessary the transport of any appeciable quantity of fuel to the depots at Aleppo and Rayak.

Engines from the Tripoli depot do the passenger train return journey, Tripoli-Aleppo. They take in the main supply of fuel at Tripoli, and a small supplementary supply at Homs to complete the remainder of the journey.

General Administration of Railways and Public Works.

RAILWAY FROM SMYRNA TO CASSABA AND EXTENSIONS.

III. — One or more evaporation and consumption tests are carried out in respect of each delivery of fuel received.

IV. — Fuel is purchased from a selected list of contractors.

V. — Fuel is paid for at the price fixed by the contract.

VII. — American coal has been tried, but its use has had to be abandoned in view of its excessively high price. The two qualities of coal at present used are Cardiff and Heraclea. They are used in varying proportions according to the nature of the line, the proportion of Cardiff coal being higher for sections of line which have the heaviest gradients.

VIII. — The various kinds of fuel are loaded separately on the tenders, and the drivers use them in proportions depending on the nature of the line.

French West Africa.

DAHOMEY RAILWAY COMPANY (FRENCH).

I. Good quality briquettes are used. There are no standing regulations with regard to fuel.

IV. — Contracts are entered into at fixed prices for cash payment.

V. — A fixed price, based on the quality of the fuel in question, is stipulated in each contract.

VIII. — Preparation : the briquettes are broken by hand on the tender as they are required.

IX. — 1° In the open air, on the ground, 800 metres (1/2 mile) from the sea; 2° about 1 500 tons.

X. — The net cost includes the purchase price, rail transport in Europe, freightage, insurance, unloading duties, weighing, storage.

EAST DAHOMEY RAILWAY.

I. — Briquettes are used, made from Cardiff or similar coal.

IV. — Orders are placed on quotations obtained through the « Agence générale des Colonies ».

V. — Each contract clearly specifies the technical conditions to be complied with.

IX. — Stocks are kept in the open air.

KAYES-NIGER RAILWAY.

I. — Contracts are subject to the approval of the Ministry for the Colonies.

II. — The briquettes used are similar in quality to Cardiff « Double Crown » briquettes.

IV. — The methods of purchase are :

In the case of coal : By open tender (subject to the approval of the Ministry for the Colonies);

In the case of wood : By contracts with a selected number of contractors. (The administration also has its own wood-cutting establishments.)

V. — The wood used as fuel is paid for at a fixed price.

VIII. — The following are the proportions adopted for mixed wood and coal fuel :

Coal 1/3rd to 1/6th, wood 2/3rds to 5/6ths, according to supplies available.

IX. — 1° The fuel depots are situated at Kayes and Bamako for fuel arriving respectively via the Senegal or the Niger.
2° The stocks kept are sufficient for one year.

KONAKRY-NIGER RAILWAY.

I. — The fuel used on this railway consists of briquettes and wood.
The briquettes used are similar in quality to Cardiff « Crown » briquettes.
The wood used for fuel is cut along the railway line by special gangs employed by the railway. It is then taken by collecting trains to the different fuel depots, and after being dried more or less completely (in the open air or under cover) it is distributed to the drivers. This wood is of very varying quality.

III. — Coal is obtained from France.
No complete test has yet been carried out with the wood used for fuel.
The receiving service only supervises the general quality of the fuel received.

IV. — Orders are generally placed on standing contracts or on quotations specially invited by the Ministry for the Colonies.

IX. — The wood is stored at the depots situated at the beginning of the various sections of line, viz. Conakry, Kindia, Mamou, Dabola, Kouroussa and Kankan; the size of the stocks at these centres is in the following respective proportions : 1, 2, 2, 2, 2, 1.

Italy.

STATE RAILWAYS.

I. — Our fuel supplies are constituted :

a) by coal purchased abroad, almost exclusively from England;

b) by coal received from Germany under the reparations settlement.

The coal purchased in England is chiefly Cardiff coal (large ordinary) and Newport coal.

II. — We have agents in England and Germany to deal with questions relating to our coal supplies.

a) The personnel engaged in this work is as follows :

In our Cardiff office :
1 chief engineer;
1 doctor of chemistry;
1 clerk;
Several employees for various duties.

In our Duisburg office :
1 chief engineer;
2 assistant engineers;
8 employees for various duties.

In our Duisburg office :
1 chief engineer;
21 employees for various duties.

b) We have a laboratory at Rome, with three qualified chemists, for the testing of fuel.
Tests are carried out to ascertain the percentage of volatile matter, of fixed carbon, of ash, of moisture and of sulphur. The calorific value of fuel is ascertained by means of the Mahler bomb calorimeter.
In addition to the above tests, practical locomotive trials are made in the case of each delivery.

IV-V. — Coal purchased is always paid for at the price fixed in advance.

VI. — Details regarding the consumption of fuel by various types of locomotives :

A. — *Locomotives having a consumption of more than 600 kgr. per square metre (122.89 lb. per square foot) of grate per hour.*

We have no locomotives of this type.

B. — *Locomotives having a consumption of from 400 to 600 kgr. per square metre (81.92 to 122.89 lb. per square foot) of grate per hour.*

These figures are only attained in the case of one section of mountain line, and then only during a short period (about 45-60 minutes). The section in question is that between Pistoia and Porretta on the line from Florence to Bologna; it is 35 km. (21.7 miles) long, and has a gradient of 25 per mil for a distance of 25 km. (15.5 miles).

We have also a mountain service with this consumption on the line from Bolzano to Brennero, with locomotives of the 480 type.

The fuel used is generally English coal mixed with a quarter of the weight of briquettes.

The vacuum in the smoke box, when the consumption is at the rate of 450 kgr. per square metre (92.16 lb. per square foot) per hour, is about 120-150 mm. (4 3/4—6 inches) of water.

The average depth of the fire is from 60 to 80 cm. (1 ft. 11 5/8 in. to 2 ft. 7 1/2 in.).

About 25 000 tons of coal were consumed in 1922 on the Pistoia-Porretta service.

The number of kilometres run in 1922 by the whole of the locomotives working on the Pistoia-Porretta line was about 1 000 000 (621 400 miles).

The consumption per ton-kilometre was about 0.150 kgr. (0.541 lb. per English ton-mile); or about 0.055 kgr. per virtual ton-kilometre (0.198 lb. per virtual English ton-mile).

C. — *Locomotives having a consumption of from 200 to 400 kgr. per square metre (40.96 to 81.92 lb. per square foot) of grate per hour.*

We have about 3 000 locomotives of this category for passenger and goods trains.

The fireboxes are generally of the semi-wide type.

The vacuum in the smokebox, when the consumption is at this rate, is from 30 to 40 mm. (1 3/16 to 1 9/16 inches), with a mixture of German and English coal. Briquettes are also added in the proportion of 1/5th to 1/6th of the total consumption.

The total consumption for this section of the service is about 1 500 000 tons, giving a consumption per actual ton carried of 0.060 kgr. (0.134 lb. per English ton). The consumption per virtual ton carried is about 0.035 kgr. (0.078 lb. per English ton).

The average ratio between the weight of the complete train (including the locomotive) and the tonnage carried was 1.25 for the year 1922.

D. — *Locomotives having a consumption of less than 200 kgr. per square metre (40.90 lb. per square foot) of grate per hour.*

This applies to all locomotives running on light railways (« secondary » or « local » railways) or engaged in shunting operations.

We have about 3 500 locomotives coming within this category.

The following are figures relating to the total fuel consumption of the State Railways in 1922-1923 :

Consumption per ton-kilometre (per English ton-mile). . .	0 kgr. 0839 (0.3024 lb.).
— per virtual ton-kilometre (English ton-mile) .	0 kgr. 0665 (0.2397 lb.).
— per locomotive-kilometre (per locomotive-mile)	21 kgr. 56 (76.49 lb.).
— per shunting hour.	85 kgr. 3 (188.1 lb.).

The total consumption for the year 1922-1923 for the whole of the locomotives in use (5 100) was 2 561 800 tons.

Locomotives with tenders have a fuel capacity of from 4 to 6 tons (3.9 to 5.9 English tons). The tank-locomotives have a coal capacity of from 2 to 4 tons (1.9 to 3.9 English tons).

REGGIO-EMILIA RAILWAY.

I. — Cardiff anthracite.

II. — The calorific value must not be less than 8 000 calories (14 400 British thermal units per lb.).

The percentage of small coal must not exceed 10 %.

The coal must not contain shale or other foreign matter.

It must be a dull black.

III. — 1° The personnel of the receiving service comprises :

1 chemist for analyses;
1 controller of the traction service for supervising practical consumption tests;
1 storekeeper;
3 labourers for distribution of the fuel.

2° The analyses take place in a laboratory which does not belong to the railway. There is in addition a calorimetric test per 200 tons by means of the Thompson calorimeter. These results are confirmed by practical tests.

IV. — Purchases are made on private contracts entered into with certain well-known contractors at the best possible prices having regard to current market rates.

V. — Fuel is paid for at the price fixed in advance.

VI. — The coal depot is situated at the junction of the three branches of the railway. The stock comprises about 100 days supply.

Japan.

RAILWAYS OF THE JAPANESE IMPERIAL GOVERNMENT.

1. — *a*) The solid fuel comprises coal of two kinds : screened coal and rough coal.

Special regulations have been adopted with regard to the proportion of small coal which they shall contain. The maximum proportion in the case of screened is 10 % at the mine and 20 % on delivery; in the case of rough coal it is 50 % both at the mine and on delivery;

b) The liquid fuel used consists of the heavy petroleum oils or petroleum itself.

There are special regulations with regard to specific gravity, flash point and viscosity.

These characteristics vary more or less as between products of the country and imported products, but the general rule is that the products are accepted if the gravity is less than 0.96, if the flash point is 150° C. (302° F.), and if the oil remains liquid at 25° C. (77° F.).

III. — 1° Delivery of coal bought at the mine is made to the nearest coal depot. In cases where deliveries are made to engine depots, the personnel of the depot takes delivery of the coal. When delivery is made to the general stores, the fuel is received by special officials. The total number of men engaged in these operations is eighty.

3° A) Deliveries by bulk are charged for according to the volume of the bulk. When delivery is taken at the mine, the coal is loaded on wagon and the weight is estimated according to the capacity of the wagon.

B) In the case of heavy oils, the quantity is measured by volume.

Luxemburg.

PRINCE-HENRI RAILWAYS AND MINES.

I. — Liquid fuel is not used. The regulations regarding solid fuel (coal) are the same as those of the Belgian State Railways so far as half-rich coal is concerned.

III. — Tests are not carried out on any fixed plan. Use is made in the tests of the combustion oven.

IV. — Purchases are made either on terms arranged in each individual case, or on contracts of varying length.

V. — Fuel is paid for at the price fixed in advance.

VIII. — There are no fixed regulations with regard to the mixing of different kinds of fuel.

IX. — There are no special regulations with regard to storage of fuel.

X. — Net costs are worked out monthly on the deliveries made during the month.

Norway.

STATE RAILWAYS.

III. — 1° The State Railways purchase coal from certain selected mines and of well-known qualities. The delivery must be accompanied by a certificate from the mine with regard to quality and weight. Analyses are not, therefore, carried out in respect of each delivery at the time of receipt. Tests are, however, carried out frequently to determine whether the qualities supplied are in accordance with specification. The State Railways have a laboratory at Christiania which carries out these tests;

2° The personnel of this laboratory comprises : one chemist, one assistant chemist, and one laboratory assistant;

3° Laboratory tests are carried out to determine : percentage of moisture; percentage of ash; nature of the coke; calorific value (by means of a calorimeter); in certain cases the tests are confined to ascertaining the percentage of fixed carbon, of hydrogen and of sulphur. (This latter analysis constitutes an elementary analysis).

For the purposes of these tests, a sample of the fuel is taken at the time of delivery;

4° Determination of the percentage of moisture and of ash is arrived at by the usual processes; the Muck method is used for determination of the nature of the coke and the percentage of volatile matter; calorific value is obtained by means of the Berthelot Mahler bomb calorimeter. Elementary analyses are made from time to time on the Dennstedt method;

5° Practical tests are carried out occasionally to ascertain the value of the fuel in actual practice.

IV. — Generally the Norwegian State Railways invite tenders for the supply of coal.

The coal is paid for at a fixed price, delivered to a specified port.

The State Railways themselves transport the coal to its final destination in Norway; for this purpose they have a 2 500 ton steamer, on which, in addition, goods are carried for other parties up to the limit of the cargo accommodation.

Up to the present the fuel required has been principally derived from Great Britain. Contracts are entered into directly with the British exporters or their representatives.

The term of the contracts depends on the state of the market. As a result of the great fluctuations which have characterised the latter during recent years, contracts are not at present entered into for longer than from two to three months.

During recent years coal has been bought in Spitzbergen. This coal is delivered c. i. f. at the Norwegian port.

V. — Coal is purchased at fixed prices. The chemical analyses and the practical tests show which kinds of coal are best suited to the various needs of the State Railways.

In the case of Spitzbergen coal, the qualities of which are not so well known, it has been decided to specify a minimum calorific value and a maximum percentage of ash. If the actual percentage of ash exceeds the specified limit, the price is reduced by 1 % for every 1/2 % or fraction of 1/2 % in excess of the limit.

IX. — The coal depots are situated as far as possible in the most convenient positions for feeding the locomotives.

The stocks held are normally sufficient for six or eight months.

Holland

a) Continent.

DUTCH RAILWAYS.

I. — The coal must be of high quality.

II. — There must be at least 40 % of large coal.

III. — The officials in charge of the engine depots supervise the reception of deliveries of coal. The quality of the coal is ascertained by inspectors during the running of trains, as regards the quantity consumed, the ash produced, etc.

IV. — Purchases are made on limited contracts.

V. — Prices are fixed.

IX. — The coal depots receive their supplies either from Germany or from Holland itself, according to their relative situation with regard to the mines from which supplies are derived.

b) Colonies.

DUTCH EAST INDIAN RAILWAY COMPANY.

I. — The fuel principally used is the wood *Tectona grandis* (Java teak). The wood must be without bark, dry and of good quality. Unsplit trunks and branches cannot be accepted. The wood is delivered in pieces 50 cm. (1 ft. 7 11/16 in.) long and 1 dm² (15.5 square inches) in section; the width must not exceed 20 cm. (7 7/8 inches). The wood is delivered free on wagon at one of the stations on the railway. It is paid for per ton delivered. The weight of the wood supplied is ascertained by weighing the loaded wagons at the weighing-machine. If the wood has not been weighed within two days after receipt, the weight is estimated at the rate of 440 kgr. per cubic metre (stere) (27.5 lb. per cubic foot).

II. — Calorific value = 4 500 kilogram-calories (8 100 B. T. U. per lb.). Specific gravity = 0.67. Weight per cubic metre = 425 to 440 kgr. (26.5 to 27.5 lb. per cubic foot). Percentage of moisture = ± 12 %.

The net price per ton on the tender in Dutch florins, and the consumption in tons, are :

Year.	Wood.		Coal.		*Remarks.*
	Price.	Consumption.	Price.	Consumption	
1913	5.16	32 614	18.20	26 002	Coal is used when the necessary quantities of wood cannot be obtained.
1914	5.25	51 630	18.20	15 322	
1915	5.27	68 018	17.05	3 316	
1916	5.35	75 761	...	...	
1917	6.27	78 948	...	...	
1918	11.55	80 710	...	...	
1919	11.55	85 959	...	...	
1920	13.60	75 470	70 30	10 983	
1921	16.60	43 808	51.40	40 641	
1922	15.60	81 211	40.80	15 166	

IV. — Limited number of contracts, for long periods.

V. — Fixed price.

IX. — 1° The wood is supplied from the forests to the nearest stations, and is thence distributed to the various fuel depots.

2° The minimum reserve of wood held at the fuel depots must be sufficient for about five months.

The stacks must not be more than 4 metres (13 ft. 1 1/2 in.) in height. They are separated by passages 5 metres (16 ft. 5 in.) wide. The wood yard is divided into several groups of stacks by means of passages 10 metres (32 ft. 10 in.) in width.

The wood must be at least 20 metres (65 ft. 8 in.) away from the buildings.

Dutch East Indies.

STATE RAILWAYS OF THE ISLAND OF JAVA.

I. — There are no special regulations with regard to the supply of fuel.

III. — 1° Three employees for the stores;

2° There is no laboratory specially devoted to the testing of fuel. The samples of fuel to be tested are sent to the « Public Works » laboratory;

3° and 5° Coal deliveries are received in three ports of the Island of Java. After receipt of a delivery of coal, a sample, consisting of about 0.5 % of the weight of the delivery, is tested on a screen consisting of a sheet-iron plate perforated with holes 30 mm. and 10 mm. (1 3/16 and 3/8 inches) in diameter.

The quality of the coal is decided according to the quantity which does not pass through the screen with the 30 mm. holes :

75 % is considered as *good.*

The following grades are considered *satisfactory :*

Less than 75 % down to and including 70 % of large coal;

Less than 70 % down to and including 65 % of large coal;

Less than 65 % down to and including 60 % of large coal;

Less than 60 % down to and including 50 % of large coal;

Less than 50 % of large coal is considered as *bad.*

The coal which passes through the 10 mm. holes is considered « dust ».

Coal containing more than 20 % of dust and more than 2 % of gangue is rejected.

IV. — Fuel is purchased by the following methods : direct purchase, long-term contracts subject to revision of prices in the case of pit coal; and, in the case of wood *(djati-teak),* contracts at fixed prices.

V. — Wood is paid for at a fixed price.

The price of coal depends partly on the quality and on the percentage of moisture.

IX. — The solid fuel (coal and wood) is generally unloaded in heaps containing from 100 to 200 metric tons. In the case of coal the average height of the stacks is 1.5 metres (4 ft. 11 in.), with a maximum of 2 metres (6 ft. 6 3/4 in.), in the case of coal liable to heat; and a height of 3 metres (9 ft. 10 in.), with a maximum of 4 metres (13 ft. 1 1/2 in.), for coal where this danger does not exist.

As regards wood, the permissible height is about 2 metres (6 ft. 6 3/4 in.), and the area of the base of each stack must not exceed 400 square metres (4 300 square feet); passages at least 5 metres (16 ft. 5 in.) wide must be left between the stacks.

X. — The average net cost per ton and per annum is calculated for each class of fuel.

Kingdom of the Serbs, Croats and Slovenes.

STATE RAILWAYS.

QUESTION *a* :

I. — The locomotives used are constructed for the burning of solid fuel; we do not use liquid fuel.

There are no special regulations with regard to the fuel supply; samples of coal are tested before purchases are made.

II. — The coal used gives from 4 000 to 4 800 calories (from 7 200 to 8 600 B. T. U. per lb.); it contains from 2.5 to 3 % of sulphur and from 15 to 20 % of ash, and is divided, according to the size of the lumps, into three classes : large, average, small.

The greater part of this coal can not be kept for any length of time in the open air.

III. — 1° The « coal department » of the railway administration is responsible for the distribution of fuel. Deliveries are accepted by the officials in charge of depots and workshops;

2° In another three months the railways will have a laboratory of their own. For the moment use is made of the State laboratory, for the testing of fuel;

3° Tests are carried out as considered necessary; approximately once a month;

4° *a*) Tests are carried out on locomotives to determine the number of calories, the percentage of ash, the quantity and nature of the clinkers.

b) The chemical analysis has for its object the determination of the percentage of sulphur.

V. — The price paid depends on the quality of the coal, that is to say on its calorific value, the percentage of ash, the clinkers and the sulphur

VI. — In distributing the fuel between the various fuel depots, account is taken of the types of locomotive, the nature of the line and of the trains, and the distance from the mine.

VIII. — The small coal is moistened, and then mixed with large coal in the following proportions : 1 to 1; 1 to 2; 1 to 3. The mixing is done when the coal is loaded on the tender.

IX. — The native coal must be kept in a spot which is protected from the rain and sun.

The height of the stacks must not exceed 1.5 metres (4 ft. 11 in.).

X. — 1° The price of the coal depends on the price of coal of standard type (5 260 calories [9 470 B. T. U. per lb.]);

2° If the prices of coal are to be exact, it is necessary to draw up a table containing all the known characteristics of the coal, and particularly the price *per calorie* on the basis of the chemical analyses.

Sweden.

STATE RAILWAYS.

I. — The Swedish State Railways only use those kinds of coal which have been found by experience to be of high quality. They do not use liquid fuel.

III. — 1° At all the ports where coal is received from abroad there are agents to take delivery of the shipments purchased for the railways. As these agents combine this work with other duties, it is difficult to state how many employees are occupied exclusively in connection with the reception of fuel;

2° The State Railways possess a laboratory in which the coal is analysed in various ways as soon as received at the port. The physical qualities of the coal are verified on delivery by the fuel superintendant or his representative.

IV. — Purchases in general on behalf of the Swedish State are announced in an official publication in advance; intended purchase of coal is announced in the same way. Quotations must be submitted in the form specified by the administration.

Deliveries are always made c.i.f., and the prices are consequently fixed prices.

Contracts are only entered into for short periods; there is no sliding scale of prices.

V. — Fuel is paid for at the prices fixed in advance. When a quotation has been accepted, the contract binds the two parties; all details relating to transport, payment, etc., are regulated by the contract.

VII. — The kind of coal used depends on the type of locomotive, and a comparison between the different net costs is therefore impossible.

VIII. — Where different kinds of coal are mixed, the proportions composing the mixture depend on the requirements of each particular case.

IX. — There are no rules regulating the situation of the fuel depots.

X. — The average cost of the fuel consumed is calculated monthly, and takes into account the whole of the different prices paid for the various kinds of coal used during the month.

Switzerland.

FEDERAL RAILWAYS.

1. — 1° *Rough coal.* — The coal must be of recent extraction, dry, and as far as possible free from shale or other foreign matter (particularly pyrites).

The percentage of volatile matter must not be less than $\left.\begin{matrix}22\ \%\\20\ \%\end{matrix}\right\}$ nor more than $\left.\begin{matrix}36\ \%\\25\ \%\end{matrix}\right\}$, on the average for the month.

The coal being dried in the open air, its calorific value, on the average for the month, must be at least $\left.\begin{matrix}7\,400\\7\,500\end{matrix}\right\}$ calories $\left(\begin{matrix}13\,300\\13\,500\end{matrix}\right.$ B. T. U. per lb$\Big)$, and in respect of no delivery must it be less than $\left.\begin{matrix}7\,300\\7\,400\end{matrix}\right\}$ calories $\left(\begin{matrix}13\,100\\13\,300\end{matrix}\right.$ B. T. U. per lb.$\Big)$. The calorific value is determined by the calorimetric process in oxygen at a pressure of 25 atmospheres (368 lb. per square inch).

The average monthly percentage of ash must not exceed $\left.\begin{matrix}9\ \%\\9\ \%\end{matrix}\right\}$; in the case of no single delivery must it exceed $\left.\begin{matrix}11\ \%\\10\ \%\end{matrix}\right\}$.

The average monthly percentage of sulphur must not exceed $\left.\begin{matrix}1\ \%\\1\ \%\end{matrix}\right\}$; in no single test must it exceed $\left.\begin{matrix}1.5\ \%\\1.5\ \%\end{matrix}\right\}$.

At least 60 % of the tonnage delivered must be in lumps.

N. B. — The higher figures are the proportions applicable to Sarre coal, the lower figures to Ruhr coal.

2° *Briquettes.* — The briquettes must be of the best quality, dry, and sufficiently solid to withstand the effects of transport and handling. They must be manufactured from small coal. They must not crumble in the firebox, and must give a compact coke.

Their percentage of volatile matter must be at least 17 to 20 %.

As briquettes are free from moisture, their average monthly calorific value must be between 7 500 and 7 600 calories (between 13 500 and 13 700 B. T. U. per lb.), and no single delivery must give a figure of less than 7 400 calories (13 300 B. T. U. per lb.). The calorific value is determined by the calorimetric method in oxygen at a pressure of 25 atmospheres (368 lb. per square inch).

The average monthly percentage of ash must be below 8 to 9 %.

The total percentage of sulphur, on the

average for the month, must not execeed 1 %.

The friability of the briquettes, on the average for the month, must not ~~be lower~~ than 55 %.

The briquettes must be of uniform weight. Briquettes below the standard weight can not be accepted unless by the special consent of the administration of the Federal Railways.

3° Trials have been made with the use of liquid fuel.

III. — Although there is no special receiving service, the quality of the fuel received is verified :

a) by tests;

b) by periodical inspection of stocks;

c) by chemical analysis and friability tests (the latter in the case of briquettes). The analyses are carried out in the Federal laboratory at Zurich.

IV. — Continental coal is purchased on direct contracts. These contracts, based on fixed prices, were made for long periods prior to the war, but at the present time their duration does not exceed three or at the most six months. Quotations for English coal are invited publicly.

V. — Fuel is purchased at fixed prices.

VI. — The mixture generally used consists of one-third of briquettes and two-thirds of ordinary coal.

VIII. — There is no special preparation or mixing. The different kinds of fuel are mixed on the locomotive by the fireman.

IX. — Stocks are carried according to the requirements of the service.

Czechoslovakia.

STATE RAILWAYS.

I. — The State Railways do not use liquid fuel. They use brown coal (lignite) and ordinary pit coal.

II. — The quality and chemical composition of lignite and pit coal are so different that it is not possible to give an average chemical composition.

III. — 2° As the State Railways do not possess a laboratory, tests are carried out at the Polytechnic School, or in the laboratory of Mr. Friedrich at Prague;

3° Orders and current deliveries are subject to the results of the chemical tests;

4° The calorific value is ascertained by means of the Berthelot-Mahler-Kroecker bomb calorimeter;

5° The quality of the fuel delivered is tested by trial trips with a locomotive hauling a full load, and by chemical analysis.

IV. — Purchases are made on quotations invited publicly. In view of the instability of the market, contracts are only valid for one year.

The first contracts entered into in the year 1923 were subject to revision of prices.

V. — Prices are fixed according to the calorific value. The prices may vary during the course of execution of a contract, and are fixed by the ministry of Public Works.

X. — The prices quoted are per ton at the mine. The respective prices for the different qualities of fuel are determined by comparaison with the price of a ton of standard fuel, either at the mine or c.i.f. at a particular engine depot.

TABLE I.

PHYSICAL NATURE OF FUEL.	COMPOSITION (percentages). Volatile matter.	Fixed carbon.	Ash.	Moisture.	Weight of water vaporised per kilogram of fuel.	Calorific value, in calories.	Characteristics of liquid fuel.
							Belgian State
Rich 0/70	23.70	...	14.92	...	...	...	...
Half-rich 0/70	14.80	...	14.92	...	...	...	...
Hard 0/70	10.20	...	14.92	...	...	...	...
Rough	...	...	...	...	...	...	...
Briquettes type I	...	...	...	...	...	...	...
Briquettes type II	17.40	...	9.47	...	...	...	...
Rich 0/70	22.85	...	13 50	...	...	. .	...
Half-rich 0/70	14.72	...	14.12	...	...	...	...
Quarter-rich 0/70	12.04	...	13.19	...	. .	...	...
Hard 0/70	10.00	...	14.10	...	...	. .	...
Rough	25.52	...	12.17	...	...	...	...
Briquettes type II	18.18	...	9.41	...	...	...	...
Screened	25 05	...	7.22	...	...	...	...
							South Manchuria
Fushun coal	37.43	48.76	6.93	6.80	...	..	...
Yentai coal	7.53	78.39	12.66	1.40	...	. .	...
Penshihu coal	15.28	71.41	12.65	0.65	...	...	...
							Danish State
Hard coal containing little dust	25 to 29	55 1/2 to 65	4 to 12	1.88 to 10.1	7.12 to 8.11	6 500 to 7 500	...
More friable coal with greater proportion of dust.	28 to 32	58 to 67	5 1/2 to 11.4	1.25 to 7.65	...	...	...
Coal giving little smoke, and friable	11.6 to 13.	7.3 to 7.9	5.3 to 8.5	1.25 to 2.05	...	...	...

TABLE I.

Source.	Net cost per ton (including cost of transport, handling and preparation)		Average net cost per ton in respect of transport on the railway.	Average net cost per ton in respect of handling.	Total consumption in 1922 for each class of fuel.	*Remarks.*
	in 1914 (pre-war).	in 1922.				
ilways.						
1922	Francs	Francs.	Francs.	Francs.	Tons.	
Belgium.	18.59	76.61	8.80	2.66	207 962	
England.	18.66	78.54	...	...	1 061 151	
Germany.	16.23	67.73	...	...	207 385	
Germany.	...	76.92	...	...	3 700	
...	22.49	...	...	...	22 393	Quantities in stock at 31st dec. 1921.
...	24.45	99.87	...	...	566 432	
1924						
•.	18.59	93.47	12.00	2.61	263 166	
Belgium.	18.66	95.97	...	...	1 115 324	
England.	...	91.32	...	...	40 000	
Germany.	16 23	89.43	...	...	237 383	
Germany.	...	80.15	...	...	216 626	
...	24.45	148.93	...	...	426 367	
Germany.	...	112.32	...	...	140 403	
ilway Company.						
...	...	...	...	...	...	
...	. .	...	...	...	...	
...	...	...	...	...	...	
ilways.						
	Crowns.	Crowns.			Tons (1).	
...	20 about.	40 about.	...	...	282 154.900	(1) Total consumption of all classes of fuel.
...	...	. .	...	...	...	...
...	...	...	...	...	...	...

TABLE I. (*Continued*).

PHYSICAL NATURE OF FUEL.	COMPOSITION (percentages).				Weight of water vaporised per kilogram of fuel.	Calorific value, in calories.	Characteristic of liquid fuel.
	Volatile matter.	Fixed carbon.	Ash.	Moisture.			
Alsace-Lorrai							
Screened	Variable.				...	...	...
Rough	Variable.				...	...	...
Briquettes	18/24	62/68	10	4	...	8 060	...
Eastern Railw							
Briquettes	18 to 22	...	8 to 10	4	...	...	...
Screened	17 to 35	..	5 to 8	...	..	...	...
Rough	...	...	10 to 13	...	...	..	...
Washed smalls	...	..	7 to 11	...	...	...	..
Raw smalls	...	..	12 to 15	...	...	...	...
Coke	...	...	...	...	...	...	...
Midi Railw							
Cardiff large	28.54	62 15	9.31	2.28	...	7 360	...
Cardiff rough 50 % large	21.66	68.63	9.71	1.89	...	7 480	...
Durham rough	27.87	64.35	7.78	1.78	...	7 550	...
Ruhr rough	28.60	61.20	10.20	2.80	..	7 250	...
Swansea briquettes	17.00	73.29	9.71	2.39	...	7 500	...
Carmaux. Cobbles	27.20	61.10	11.70	1.99	...	7 200	...
Nuts	27.00	62.50	10.50	2.02	...	7 310	...
Slack	26.85	63.03	10.12	2.13	..	7 350	...
Small	26.02	60.17	13.81	2 94	...	6 980	...

TABLE I. (*Continued.*)

Source.	Net cost per ton (including cost of transport, handling and preparation) in 1914 (pre-war).	Net cost per ton (including cost of transport, handling and preparation) in 1922.	Average net cost per ton in respect of transport on the railway.	Average net cost per ton in respect of handling.	Total consumption in 1922 for each class of fuel.	*Remarks.*

ailways.

	Francs.	Francs.	Francs.	Francs.	Tons.	
Sarre. Lorraine.	18.10	99.09	13.15	3.30	288 450.538	
Sarre. Lorraine. Ruhr.	18.10	92.97	13.15	3.07	466 624.474	
Manufactured at Kehl and Strasburg rom Ruhr slack.	24.97	109.69	13.15	3.71	67 371.680	

ompany (France).

			In 1914.	In 1922.	In 1914.	In 1922.	Tons.	
	Francs.	Francs.	Francs.	Francs.	Francs.	Francs.	170 910	As the railway uses mixed fuel, it is possible for the percentage of volatile matter in the various kinds of fuel to vary considerably. No limit is stipulated in respect of fixed carbon.
France.								
Belgium.								
Germany.	25.385	105.611	3.158	9.504	0.95	5.20	242 678	
England.	...	...	...		...		396 446	
Holland.	...	...	...		...			
..	...	...	...		...		15 676	

ompany (France).

			In 1914.	In 1922	In 1914.	In 1922.	
	Francs.	Francs.	Francs.	Francs.	Francs.	Francs.	
...	18.76	105.78	3.01	6.28	0.43	1.10	...
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...
...	22.28	97.81	...	...	...	...	...
...	30.37	120.40	...	...	...	...	...
...	17.69	91.10	...	...	...	...	...
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...

Total consumption :	621 593 t.
Briquettes	142 239 t.
Large	48 365 t.
Cobbles	14 575 t.
Rough	331 984 t.
Nuts	21 705 t.
Small	51 899 t.
Various	10 826 t.

TABLE I. (*Continued*)

PHYSICAL NATURE OF FUEL.		COMPOSITION (percentages). Volatile matter.	Fixed carbon.	Ash.	Moisture.	Weight of water vaporised per kilogram of fuel.	Calorific value, in calories.	Characteristics of liquid fuel.
								Midi Railway Compan
Albi	Briquettes	32.10	56.72	11.12	2.00	...	7 150	...
	Slack	31.04	57 36	11.60	4.30	...	6 940	...
Graissessac	Briquettes	17.83	70.67	11.50	2.00	...	7 370	...
	Slack	16.19	70.29	13.52	3.30	...	7 100	...
Bousquet	Briquettes	22.52	64.58	12.90	2.00	...	7 180	...
	Slack	20.80	66.32	12.83	5.00	...	6 960	...
								Paris-Orlean
Small		14 to 36	50 to 78	8 to 21	...	...	6 615 to 7 646	...
Average size or rough		8 to 35	48 to 86	6 to 16	...	...	7 043 to 8 193	...
Large		16 to 36	54 to 79	4 to 20	...	...	6 757 to 8 457	...
Briquettes		16 to 34	46 to 76	7 to 19	...	...	6 492 to 8 200	...
								Paris-Lyons-Mediter
Briquettes		22.50	67.50	10.00	1.50	...	7 852	...
Screened		36.00	57.50	6.50	0.50	...	7 703	...
		20 00	72.50	7.50	0.50	...	8 095	...
Rough		28.50	59.00	12.50	2.00	...	7 588	...
		26.00	63.50	10.50	2.00	..	7 781	...
Washed small		21.50	67.50	11.00	6.00	...	7 771	..
		36.00	53.50	10.50	4.50	...	7 267	...

TABLE I. (*Continued.*)

Source.	Net cost per ton (including cost of transport, handling and preparation) in 1914 (pre-war).	Net cost per ton (including cost of transport, handling and preparation) in 1922.	Average net cost per ton in respect of transport on the railway.	Average net cost per ton in respect of handling.	Total consumption in 1922 for each class of fuel.	*Remarks.*
ance) (*Continued.*)						
	Francs.	Francs.				
...	...	108.86	... ...	... ...	...	
...	22.12	98.60	... ...	... ...	...	
...	24.90	108.70	.. ...	.. ...	...	
...	16.73	78.60	... ...	... ...	...	
...	24.90	108.70	... ...	... ...	...	
...	16.73	78.60	... ...	... ...	...	
	23.57 Average cost.	103.28 Average cost.				
lway Company.						
	Francs.	Francs.		In 1914. Francs. In 1922. Francs.	Tons.	
...	22.563	100.843	...	1.155 4.058	296 400	
...	...	...	...	...	391 500	
...	...	...	...	...	333 400	
...	...	...	...	...	357 400	
					1 378 700	
ean Company.						
	Francs.	Francs.	Francs.	Francs.	Tons.	
French.	35.00	143.00	9.60	4.55	421 600	The percentages of volatile matter fixed carbon and ash refer to dry coal.
Sarre. English.	35.00	124.00	9.60	4.55	470 230	Evaporation tests have not been carried out.
Ruhr. English d American.	27.00	116.00	9.60	4.55	625 730	The rough coal consumed in 1914 was grouped with small coal for book-keeping purposes.
French. Sarre.	27.00	96.00	9.60	4.55	865 520	

TABLE I. (*Continued.*)

PHYSICAL NATURE OF FUEL.	COMPOSITION (percentages).				Weight of water vaporised per kilogram of fuel.	Calorific value, in calories.	Characteristi of liquid fuel.
	Volatile matter.	Fixed carbon.	Ash.	Moisture.			
Chalosse and Béa							
(See Midi Railway Company).							
Railways of t							
Coal	... ...	... ...	... ...	... ...	... ...	... ...	... ...
Briquettes	... ...	... .	... ...	... ...	... ...	... ...	... ...
Landes Lo							
English rough and large coal	...	...	...	...	...	...	...
Ruhr rough	...	...	...	...	...	...	...
Railways of t							
Washed small	15 to 17	69 to 70	13 to 14	1 to 2	0.070	7 500	...
Briquettes	16 to 20	68 to 69	12 to 13	0.5 to 1	0.070	7 500	...
Alger							
Briquettes	15.66	72.87	10.34	1.13	7 750	7 525	Not used.
Coal (rough)	22.22	66.15	9.41	2.22	6 925	6 850	Not used.
Kenadza coal	27.70	63.05	7.45	1.80	6 500	6 275	Not used.

Table I. (*Continued.*)

Source.	Net cost per ton (including cost of transport, handling and preparation)		Average net cost per ton in respect of transport on the railway.	Average net cost per ton in respect of handling.	Total consumption in 1922 for each class of fuel.	*Remarks.*
	in 1914 (pre-war).	in 1922.				
m Tramways.						
	Francs.	Francs.	Francs.	Francs.	Tons.	
	30.00	105.00	1.00	3.00	2 344	Cardiff rough.
n Département.						
	Francs.	Francs.		Francs.	Tons.	
Albi.	27.00	...	..	...	...	
Carmaux.	27.50	122.21	...	3.75	1 131	
Albi.	31.00	...	...	...	...	
Carmaux.	31.50	129.94	...	4.50	1 466	
raissessac.	32.00	121.81	...	4.50	478	
ways.						
	Total cost (excluding transport).				Tons.	
		Francs.				
England.	...	394 700	...	...	4 109	
ermany.	...	98 700	...	...	1 165	
ern Pyrenees.						
	Average cost.					
	Francs.	Francs.		Francs.	Tons.	
raissessac. mines	30.00	113.00	...	2.80 2.80	1 071 267	
ways.						
	Francs.	Francs.	Francs.	Francs.	Tons.	
England.	40.87	194.79	7.95	0.90	87 618.739	
England.	Not used before 1914.	235.83	7.95	0.85	28 361.790	This coal was bought during the second half of 1921.
Algeria.	Mine not worked before 1914.	186.96	25.25	0.85	6 218.000 122 198.529	Average cost: 203.91 francs.

TABLE I. (*Continued.*)

PHYSICAL NATURE OF FUEL.	COMPOSITION (percentages).				Weight of water vaporised per kilogram of fuel.	Calorific value, in calories.	Characterist of liquid fuel
	Volatile matter.	Fixed carbon.	Ash.	Moisture.			
Tunisian Rai							
Briquettes	15 to 17	68.5 to 71	10.5 to 12	1 to 4.5	7.57	7 785	...
Cardiff large	13.5 to 18	76 to 82	2.5 to 5.5	0.75 to 1.2	...	...	...
Cardift rough.	...	...	...	...	...	...	...
Mazout	...	...	...	...	...	...	Specific grav 0.946 to 0.9 Flash point: 8 Barbey fluidi at 35° = 22 at 50° = 55 at 100° = 460 Percentage of phur : 3 to 3.5
Franco-Ethiop							
Large Carrdiff briquettes	17.00	7.50	10.00	...	6.74	7 600	...
Mimosa wood.	...	...	...	...	...	...	...
General Administration of Railways and Public Wo							
Briquettes.	14.55	76.01	7.57	1.87	7.659	8 267	...
Best coal.	13.37	81.83	3.77	1.03	6.403	8 572	...
General Administration of Railways and Public Wo							
Rich coal.	...	...	10.50	4.00	7.15	7 000	...
Rich coal.	12.50	80.00	4.00	3.00	8.35	8 400	...
Compact coal	16.00	76.00	3.50	3.50	7.60	8 165	...
Lignite	33.00	35.00	16.00	13.00	3.60	4 200	...

TABLE I. (*Continued.*)

Source.	Net cost per ton (including cost of transport, handling and preparation)		Average net cost per ton in respect of transport on the railway.	Average net cost per ton in respect of handling.	Total consumption in 1922 for each class of fuel.	*Remarks.*
	in 1914 (pre-war).	in 1922.				
ompany.						
	Francs.	Francs.	Francs.	Francs.	Tons.	
Manufactured at Bizerta from Cardiff coal.	37.304	116.737	2.71	2.15	59 171.945	
England.	38.043	...	...	...	...	
England.	...	126.288	2.71	2.15	317.253	Trial made in 1922.
Tampico (Mexico).	..	438.927	2.71	2.15	68.100	The use of this fuel had scarcely begun in 1922.
Railway.						
	Francs.	Francs.	Francs.	Francs.	Kilograms.	
Various	52.00	250.00	0.05 per t.km.	2.00	3 781 350	
Local.	15.00	40.00	0.05 per t.km.	0.90	1 127 150	1 cubic metre of wood equals 200 kgr. of briquettes.
– Damascus-Hamah Railway and Extensions.						
	Francs.	Francs.	Francs.	Francs.	Tons.	
Cardiff.	44.31	199.50	16.00 (narrow gauge)	1.50	11 888.500	46 % of best coal and 17 % of briquettes consumed during the year have been carried over the line.
Cardiff.	35.42	146 80	2.34 (standard gauge)	1.50	5 262.500	
myrna-Cassaba Railway and Extension.						
	P. o.	P.	P.	P.	Kilograms.	
Heraclea.	169.10	1 693	10.9	102.5	3 277 300	P. o. = piastre-or (gold piastre); the rate of exchange in 1914 was about 4.40 P. o. to the franc.
Cardiff.	248.10	1 842	27.3	102.5	17 323 600	P. = Paper-piastre; the rate of exchange at present is about 10 P. to the franc
Pocahontas (America).	...	2 232	19.3	102.5	358 090	
Soma (Anatolia).	...	870	18.9	22.5	214 600	

TABLE I (*Continued.*)

PHYSICAL NATURE OF FUEL.	COMPOSITION (percentages).				Weight of water vaporised per kilogram of fuel.	Calorific value, in calories.	Characteristics of liquid fuel.
	Volatile matter.	Fixed carbon.	Ash.	Moisture.			
							French Railway
Briquettes (agglomerates)	17/18	...	9.00	1 1/2	..	7 700 to 7 800	Grand'Combe
Briquettes	17/18	...	9 to 10	1.00	...	7 900	Anzin.
	20.00	...	8 to 9	...	...	...	Crown.
							Dahomey East
Briquettes (agglomerates)	17/18	...	> 9.00	1 1/2	...	7 700 to 7 800	...
Briquettes	17/18	...	9 to 10	1.00	...	7 900	...
	20.00	...	8 to 9	...	...	...	...
							Kayes-Niger
Briquettes	...	...	...	...	...	...	...
Wood	...	...	...	...	...	...	...
							Konakry-Niger
Coal	...	...	...	...	...	...	...
Wood	...	...	...	...	...	...	...
							Italian State
Cardiff coal	14 to 18	70 to 76	5.00	1.00	7.8 to 8.0	8 100	...
Newport coal	22 to 28	70 to 64	7.00	1.00	7.6 to 7.8	7 800	...
German coal	22.00	70.00	7.00	1.00	7.7 to 7.9	7 900	...
Briquettes	17.00	71.00	11.00	1.00	7.5 to 7.7	7 600	...
Ditto	24.00	63.00	11.50	1.50	7.4 to 7.6	7 500	...

TABLE I. (*Continued.*)

Source.	Net cost per ton (including cost of transport, handling and preparation) in 1914 (pre-war).	in 1922.	Average net cost per ton in respect of transport on the railway.	Average net cost per ton in respect of handling.	Total consumption in 1922 for each class of fuel.	*Remarks.*
ompany of Dahomey.						
			Francs.	Francs.	Tons.	
...	...	...	...	...	...	
...	...	230	Freightage 60.00	20.00	720	
...	...	260	Freightage 60.00	20.00	720	Friability > 60.
n Railway.						
	Francs.	Francs.		Francs.	Tons.	
...	...	...	...	...	..	
Cardiff.	65.00	240.00	...	20.00	97.500	
...	...	...	...	...	...	
ilway.						
	Francs.	Francs.			Tons.	
...	119.18	468.36	...	..	1 764	
...	4.16 per ton.	10.00	...	...	8 000	
ilway.						
	Francs.	Francs.			Tons.	
...	60.00	570.00	...	...	192	
Guinea.	...	6.00 (1)	...	...	22 179	(1) Cost of transport, handling and preparation excluded.
ilways.						
	Lire.	Lire.	Lire.	Lire.	Tons.	
Cardiff.	32.00	190.00	0.07 per ton-km.	2 per ton-km.	590 000	
Newport.					400 000	
Germany.					700 000	
(1) (1)	32.00	235.00	0.07 per ton-km.	...	800 000	(1) Part of the briquettes are purchased abroad, and part are manufactured in Italy.

TABLE I. (*Continued*).

PHYSICAL NATURE OF FUEL.	COMPOSITION (percentages).				Weight of water vaporised per kilogram of fuel.	Calorific value, in calories.	Characteristic of liquid fuel.
	Volatile matter.	Fixed carbon.	Ash.	Moisture.			
Reggio-Emil							
Anthracite	20.00	80.00	6.00	2.50	8.00	8 000	...
Railways of the Japane							
Machida coal	40.07	30.29	26.10	3.59	...	5 399	...
Furakawa coal	34.32	30.75	24.15	10.78	...	4 927	...
Naigo coal	37.74	30.90	23.55	7.81	...	5 072	...
Hirayamana-Roman coal	31.38	46.26	20.67	1.69	...	6 154	...
Kishima coal	35.89	52.16	10.66	1.29	...	7 122	...
Fukuoka coal	38.50	46.46	13.03	2.03	...	7 136	...
Yubari coal	39.36	50.45	8.87	1.32	...	7 610	..
Miuta coal	41.48	46.56	8.89	3.07	...	7 098	...
Karachi coal	35.28	50.73	11.81	2.18	...	7 096	...
Prince-Her							
Coal	Type IV, Belgian State, half-rich, 0/80				..	...	...
Briquettes	Type VI, Belgian State				...	...	...
Norwegian Sta							
Durham coal	31.60	60.10	6.30	2.00	...	7 463	...
Yorkshire Association best coal	35.00	57.90	4.00	2.80	...	7 459	...
Northumberland coal	31.40	58.40	3.50	6.70	...	6 903	...
Cardiff Nizon	11.10	81.60	6.50	0.80	...	7 850	...
Spitzbergen coal	36.50	56.20	4.90	2.40	..	7 435	...

TABLE I. (*Continued*).

Source.	Net cost per ton (including cost of transport, handling and preparation)		Average net cost per ton in respect of transport on the railway.	Average net cost per ton in respect of handling.	Total consumption in 1922 for each class of fuel.	*Remarks.*
	in 1914 (pre-war).	in 1922.				
Railway.						
	Lire.	Lire.		Lire.	Tons.	
...	90.00	250.00	...	15.00	2 000	
Imperial Government.						
					Tons.	
Japan.	...	...	...	...	96 511	
Ditto.	...	...	...	...	52 083	
Ditto.	...	...	...	...	46 511	
Kyushyu.	...	...	...	...	81 393	
Ditto.	...	...	...	...	51 185	
Ditto.	...	...	...	...	59 940	
Hokkaido.	...	...	...	...	320 010	
Ditto.	...	...	...	...	73 899	
Ditto.	...	...	...	...	63 933	
Railways and Mines.						
	Francs.	Francs.			Tons.	
Belgian.	26.40	70.91	...	...	46 870	The average costs quoted do not include the cost of handling.
Ditto.	28.03	106.47	...	...	4 804	
Railways.						
	Crowns.	Crowns.	Crowns.		Tons.	
...	20.00	47.45	5.00	...	183 500	
...						
...						
...						
...						

TABLE I. (*Continued.*)

PHYSICAL NATURE OF FUEL.	COMPOSITION (percentages).				Weight of water vaporised per kilogram of fuel.	Calorific value, in calories.	Characteristics of liquid fuel.
	Volatile matter.	Fixed carbon.	Ash.	Moisture.			
Dutch							
Coal	24.00	69.00	6.00	1.00	...	7 900	...
Briquettes	16.00	75.50	7.50	1.00	...	7 800	...
Coal	25.00	68.00	5.00	2.00	...	7 750	...
Dutch East							
Pit coal — Ombilin	34.00	56.00	2.00	8.00	...	7 200	...
Pit coal — Poeloe Laoet	39.00	48.00	7.50	5.50	...	6 800	...
Pit coal — Boekitasen	40.00	44.00	0.50	15.00	...	6 400	...
Pit coal — Koetoei	35.00	55.00	2.00	10.00	...	7 300	...
Firewood	...	...	...	...	...	...	...
Swedish State							
Durham coal	32.40	56.50	8.90	2.20	...	7 300	...
Northumberland coal	31.90	52.00	8.40	7.70	...	6 650	...
Scottish coal	32.70	48.90	7.60	10.80	...	6 270	...
Fairmont coal	38.30	51.90	8.00	1.80	...	7 400	...
Swedish coal	29.00	40.60	16.10	14.30	...	5 000	...
Spitzbergen coal	26.70	59.70	10.20	3.40	...	7 050	...
Railways of the							
Lignite of inferior quality	15.25	35.75	10.38	38.62	5.03	3 163	...
Good quality lignite	19.52	67.51	2.41	10.56	10.46	6 589	...
Coal of inferior quality	14.93	51.59	31.67	1.76	7.68	4 836	...
Good quality coal	13.95	71.41	7.65	6.99	10.74	6 764	...

TABLE I. (*Continued.*)

Source.	Net cost per ton (including cost of transport, handling and preparation)		Average net cost per ton in respect of transport on the railway.	Average net cost per ton in respect of handling.	Total consumption in 1922 for each class of fuel.	*Remarks.*
	in 1914 (pre-war).	in 1922.				
Railways.						
	Florins.	Florins.			Tons.	
Holland.	8.00	19.70	...	...	764 000	In this total is included a certain quantity of English coal, several thousand tons of which have been bought from time to time.
Holland.	...	...				
Germany.	...	...				
ndian Railways.						
	Florins.	Florins.	Florins.	Florins.	Tons.	
Sumatra.	13.33	32.41	2.40	1.94	140 320	
Borneo.	11.83	33.46			79 992	
Sumatra.	...	37.26			13 577	
Borneo.	...	37.71			87 610	
Java.	5.69	14.08	2.85	1.36	31 284	
Railways.						
		In 1923.			Tons.	
England.	...	...	...	...	62 900	Price *c. i. f.* at Swedish port. 27/10 1/2 — 44/4.
England.	...	...	...	...	140 300	
Scotland.	...	...	...	...	99 700	
United States of America.	...	$ 8.75 to 10.00	...	..	12 400	
...	..	...	...	...	94 000	The prices are calculated on the basis of the price of foreign fuel.
...	...	...	...	...	70 000	
Czechoslovakian Republic.						
	Czechoslovak. Crowns	Czechoslovak. Crowns			Tons.	
Czechoslovakia.	from 3 to 10.70	143.22	...	...	3 361 925	The cost of transport is calculated according to the railway rates, the mines being connected with the railways.
Czechoslovakia.						
Czechoslovakia.	from 9.90 to 17.79	399.64	...	...	1 410 500	
Czechoslovakia.						

TABLE II.

Designation of the class of locomotive according to the consumption per square metre of grate area per hour : A = Consumption exceeding 600 kgr. B = — between 400 and 600 kgr. C = — — 200 and 400 kgr. D = — below 200 kgr. E = Other types.	Types of firebox.	Number of locomotives in each class.	Number of kilometres run in 1922 by the whole of the locomotives in each class including light running.	Number of hours of shunting or corresponding number of kilometres, in 1922.	Nature of fuel used including liquid or pow dered fuel.) Nature of mixtures, where used.	Average depth of fire.	Vacuum in smokebox for a given standard of firing.	Consumptio per ton-kilometre.	
								Weight.	Cost.
								Belgian Stat	
				Kilom. (1)					
B.	Various.	1 378	31 667 357	1 712 695	(See table I).	500	120	...	...
C.	Ditto.	1 988	35 310 519	5 277 165		300	80	...	...
D.	Belpaire.	1 364	19 790 258	9 703 591		150	50	...	...
								South Manchuri	
								Per short ton mile.	
			Miles.					Lb.	Yen.
« Switcher » 4-6-2.	Wagon narrow	...	...	...	...	15 inches for narrow fireboxes and 10 inches for wide fireboxes.	Height of water about 6 inches.	...	...
« Switcher » 2-6-4.	Ditto.	...	1 238 536	...	...			...	...
« Switcher » 0-8-0.	Wagon Wide.	...	...	...	...			...	...
« Inspection » 2-2-4	Ditto.	...	3 159	...	...			...	...
« Prairie » 4-6-2	Wagon narrow	...	955	...	...			0.145	0.00079
« Prairie » 2-6-4	Ditto.	...	295 523	...	...			0.145	0.00082
« Consolidation » 2-8-0 1 . . .	Ditto.	...	1 167 194	...	...			0.121	0.00051
« Consolidation » 2-8-0 2 . . .	Wagon Wide.	...	516 666	...	...			0.091	0.00052
« Consolidation » 2-8-0 3-4 . .	Belpaire narrow.	...	1 528 514	...	...			0.094	0.00052
— 0-8-0	Wagon narrow	...	217 974	...	...			0.088	0.00048
« Mikado » 2-8-0.	Wagon Wide.	...	725 167	...	...			0.084	0.00046
« Decapod » 2-10-0.	Wagon narrow	...	1 339 476	...	...			0.192	0.00056
« American »	Ditto.	...	86 361	...	...			0.234	0.00129
« Ten Wheeler » 4-6-0 1. . . .	Ditto.	..	830 422	...	...			0.155	0.00085
« Ten Wheeler » 4-6-0 2. . . .	Belpaire narrow.	...	117 830	...	...			0.175	0.00096
« Pacific » 1	Wagon Wide.	...	293 086	...	...			0.176	0.00096
« Pacific » 2	Ditto.	...	246 291	...	...			0.118	0.00065
« Pacific » 3	Ditto.	...	587 166	...	...			0.115	0.00064
								Danish Stat	
						Mm.	Cm.		
The consumption per square metre of grate area does not as a rule exceed 400 kgr. per hour.	...	...	...	7702 100	...	300 to 500	8 to 10	0 65	0.26
								Railways o	
				Kilometres.		Cm.	Mm.	Kgr.	Francs.
Type B S12-S14	Belpaire.	47	The available statistics do not permit of a reply to this question.	6 433 510	Screened and rough coal.			0 053	5.10
Type B S10-G8-G10-G12-G14 .	Crampton.	651				20to30	80to10		
Type C S5-S9-P7-G11-T17 . .	Belpaire.	280			Ditto.	20to30	80to10		
Type C S3-S7-P2-P3-P6-P8 . .	Crampton.	772			Ditto.	20to30	80to10		
Type C G1-G2-G3-G4-G5-G7. .					Ditto.	20to30	80to10		
Type C T9-T11-T12-T13-T14 .					Ditto.	20to30	80to10		
Type C T16-T18-T31-T37 . . .					Ditto.	20to30	80to10		
Type D : T3-T4-T5	Crampton.	84			Ditto.	20to30	80to10		

TABLE II.

net cost (including cost of transport and handling) in 1922								Total weight consumed in 1922 by the whole of the locomotives in each class.	How often is coal put on the locomotive (tender or bunker)?	*Remarks.*
per virtual on-kilometre		per train-kilometre.		per locomotive-kilometre.		per shunting hour.				
eight.	Cost.	Weight.	Cost.	Weight.	Cost.	Weight	Cost.			
lways.										
				Kgr.	Francs.	Kgr.	Francs.			
...	...	...	...	21.58	2.04	84.24	7 48	...	...	(1) The journeys included in this column are also included in the figure in the preceding column.
...	...	...	...							
...	...	...	...							
lway Company.										
				Per engine mile. Lb.	Yen.			Shor ton.		
...	...	...	...	...	...	...	...	...	...	
...	...	...	...	77.30	0.426	...	...	48 824	...	
...	...	...	...	...	...	...	...	...	...	
...	...	...	..	28.7	0.158	...	...	...	...	
...	...	...	...	102.8	0.565	...	...	...	...	
...	...	...	...	145.7	0.802	...	...	...	...	
...	...	...	...	103.2	0.609	...	...	...	...	
...	...	...	...	113.8	0.566	...	...	...	...	
...	...	...	...	113.8	0.626	...	...	...	...	
...	...	...	...	95.3	0.525	...	...	...	...	
...	...	. .	...	117.9	0.649	...	...	...	...	
..	...	...	...	117.9	0.649	...	...	...	. .	
...	...	...	...	52.3	0.288	...	...	...	...	
...	...	...	...	154.2	0.847	...	...	...	...	
...	. .	...	...	78.3	0.481	...	...	...	...	
...	...	...	...	79.5	0.437	...	...	...	...	
...	...	...	...	59.6	0.328	...	...	...	...	
...	...	...	...	55.0	0.325	...	...	...	...	
ilways.										
					öre.		öre.			
...	...	...	...	12.6	50.4	65.0	260	...	...	
sace-Lorraine.										
		Kgr.	Francs	Kgr.	Francs.	Kgr. per hour.	Francs.			
...	...	21.4	2.35	22.2	2.14	120	11.56	...	5 or 6 times per 1 000 km for locomotives with separate tender. 8 to 10 times for tank-engines.	

Table II. (*Continued.*)

Designation of the class of locomotive according to the consumption per square metre of grate area per hour : A = Consumption exceeding 600 kgr. B = — between 400 and 600 kgr. C = — — 200 and 400 kgr. D = — below 200 kgr. E = Other types. (1)	Type of firebox. (2)	Approximate class according to hourly consumption. (3)	Consumption per kilometre per square metre of grate area. (4)	Number of locomotives in each class. (5)	Number of kilometres run in 1922 by the whole of the locomotives in each class (including light running). (6)	Number of hours of shunting, or corresponding number of kilometres, in 1922. (7)	Nature of fuel used (including liquid or powdered fuel). Nature of mixture, where used. (8)	Average depth of fire. (9)	Vacuum in smokebox (
							Eastern Railw		
a-c	*b*	*c*	Kgr.		*Explanation.* R. = Route G. = Station		*d*		
Series VI (tank-engines). 0-3-0	...	A	23.667	5	R. 49 231 G. 282	32 h. 30 m. 47.60 km.	Mixture C.	...	
Series XIII . . . . 1-3 + 3-0	...	B	16.742	1	R. 4 253	47 h. 40	...	..	
Series V. 0-3-0	...	B	16.627	3	G. 6 280	998 h. 10	Mixture C.	...	
Series VI (tank engines). 0-3-0	...	B	16.242	1	G. 7 532	1 177 h. 20	Mixture C.	...	
Series VII. 0-3-0	...	B	16.196	10	G. 205 787	30 886 h. 10	Mixture C.	...	
Series II. 1-2-0	...	A	15.534	4	R. 18 466 G. 1 910	4 h. 10 295 km. 00	Mixture B.	...	
Series VIII (tank engines). 1-3-0	...	B	15.357	1	G. 5 183	808 h. 10	Mixture B.	...	
Series VI 0-3-0	...	B	15.053	19	R. 151 665 G. 53 407	3 028 h. 10 8 374 km. 20	Mixture B. Mixture C.	...	
Series VII. 0-3-0	...	B	14.366	5	R. 4 010 G. 8 986	304 h. 30 2 km. 00	Mixture B. Mixture C.	...	
Series IX (« Mallet » locomotives) . . 0-2 + 2-0	...	B	13.832	8	R. 48 700 G. 11 050	782 h. 10 1 706 km. 00	Mixture B. Mixture C.	...	
Series III 1-2-1	...	A	12.931	23	R. 198 913 G. 78 403	1 286 h. 00 10 892 km.50	Mixture B. Mixture C.	...	
Series XIII (tank engines) 1-5-1	...	B	12.874	2	R. 10 280	20 h. 40	Mixture B.	...	
Series IX 0-4-0	...	C	12 600	41	R. 493 058 G. 92 287	9 864 h. 30 15 245 km.10	Mixture B. Mixture C.	...	

TABLE II. (*Continued.*)

Consumption and net cost (including cost of transport and handling) in 1922.										Total weight consumed in 1922 by the whole of the locomotives in each class.	How often is coal put on the locomotive (tender or bunker)?	*Remarks.*
per ton-ilometre.		per virtual ton-kilometre.		per train-kilometre.		per locomotive-kilometre.		per shunting hour.				
ight 11)	Cost. (12)	Weight (13)	Cost. (14)	Weight (15)	Cost. (16)	Weight (17)	Cost. (18)	Weight (19)	Cost. (20)	(21)	(22)	(23)
ompany.												
gr.	*e*		*e*	Kgr.	*e*	Kgr.	*e*	Kgr.	*e*	Tons.	*f*	*a*) The figures placed under the designation of the series of locomotives indicate : 1) independent leading bogies or axles ; 2) the number of coupled axles, 3) independent trailing bogies or axles. *b*) See table 3 (column 2). *c*) The statistics kept by the railway do not enable us to determine exactly the *hourly* consumption ; we calculate the consumption per kilometre. We have, however, indicated for each series of locomotives the category in which it should apparently appear according to the approximate hourly consumption. *d*) We have indicated in this column the mixture of fuel ordinarily used for a particular series of locomotives. *e*) The company does not calculate the average net cost of each mixture of fuel, but the average net cost of all the different kinds of fuel used. For the financial year 1922 this net cost was 105 fr. 64 c. per ton loaded on the tender. *f*) If the desired information refers to the firing of fuel into the firebox (which varies greatly according to the type of locomotive and the nature of the train pulled), the company has no statistics to enable it to reply. If it refers to the frequency of loading fuel on the tender, locomotives are supposed in principle to take in a complete supply each time they return to their depot.
328	...	...	...	22.908	...	21.300	...	... 137.02	...	1 049 740 6 440	...	
203	. .	...	...	45.219	...	63.620	...	...	...	270 580	...	
..	...	...	...	...	...	...	...	95.69	...	100 240	...	
..	...	...	...	...	...	...	...	114.72	...	139 460	...	
..	...	...	...	...	...	...	...	113.36	...	3 832 941	...	
172	...	...	...	16.556	...	16.310	...	... 121.22	...	301 110 36 680	...	
..	...	...	...	...	...	...	...	151.74	...	125 760	...	
127	...	...	...	17.914	...	17.310	...	... 122.72	...	2 625 380 1 060 880	...	
127	...	...	...	19.330	...	16.090	....	...	...	64 520 185 375	...	
095	..	...	...	28.658	...	27.110	. .	... 191.94	...	1 320 200 345 730	...	
169	...	...	...	17.499	...	16.810	...	... 107.21	...	3 344 510 1 292 065	...	
059	...	...	...	51.497	...	39.650	...	...	...	407 590	...	
074	...	...	...	31.949	...	28.350	...	... 135.47	...	13 977 261 2 077 220	...	

TABLE II. (*Continued.*)

Designation of the class of locomotive according to the consumption per square metre of grate area per hour : A = Consumption exceeding 600 kgr. B = — between 400 and 600 kgr. C = — — 200 and 400 kgr. D = — below 200 kgr. E = Other types. (1)	Type of firebox. (2)	Approximate class according to hourly consumption. (3)	Consumption per kilometre per square metre of grate area. (4)	Number of locomotives in each class. (5)	Number of kilometres run in 1922 by the whole of the locomotives in each class (including light running). (6)	Number of hours of shunting, or corresponding number of kilometres, in 1922. (7)	Nature of fuel used (including liquid or powdered fuel). Nature of mixture, where used. (8)	Average depth of fire. (9)	Vacuum in smokebox
									Eastern Rail
a — c	*b*	*c*	Kgr.		*Explanation :* R. = Route. G. = Station.		*d*		
Series IX (« Mallet » locomotives) 0-2 + 2-0	...	C	12.454	4	R. 70 030 G. 782	1 107.40 92.20	Mixture B.	...	
Series IX 0-4-0	...	C	12.042	173	R. 1 358 329 G. 1 220 031	37 712.10 180 708.00	Mixture B. Mixture C.	...	
Series XI (tank engines) 1-4-1	...	C	11.952	28	R. 397 951 G. 17 244	9 232.00 2 233.00	Mixture B.	...	
Series XIII 1-5-0	...	B	11.904	6	R. 27 312	50.20	Mixture A.	...	
Series IX 0-4-0	...	C	11.421	3	G. 21 058	2 404.10	Mixture B.	...	
Series XI 0-4-0	...	B	11.381	31	R. 566 707 G. 4 542	13 456.00 608.10	Mixture B.	...	
Series XII 0-5-0	...	C	11.323	6	G. 111 830	18 237.40	Mixture B.	...	
Series VII (tank engine) 0-3-0	...	C	10.937	47	R. 499 G. 622 415	... 98 125.40	... Mixture C.	...	
Series VIII (tank-engine) 1-3-1	...	B	10.935	44	R. 617 893 G. 91 698	13 854.00 12 532.00	Mixture B. Mixture C.	...	
Series VIII et VIII^{bis} 0-3-0	...	C	10.448	161	R. 171 783 G. 1 645 253	7 686.40 238 261.10	Mixture B. Mixture C.	...	
Series XII 0-4-0	...	B	10.221	108	R. 1 411 148	8 774.40	Mixture A.	...	
Series IX (tank engine) 0-4-0	...	C	10.155	90	R. 244 G. 2 513 901	... 413 477.10	... Mixture C.	...	
Series XI (tank engine) 1-4-1	...	B	9.500	110	R. 2 494 909 G. 248 104	26 711.30 33 401.30	Mixture B.	...	

TABLE II. (*Continued.*)

Consumption and net cost (including cost of transport and handling) in 1922.										Total weight consumed in 1922 by the whole of the locomotives in each class. (21)	How often is coal put on the locomotive (tender or bunker)? (22)	*Remarks.* (23)
per ton-kilometre.		per virtual ton-kilometre.		per train-kilometre.		per locomotive-kilometre.		per shunting hour.				
Veight (11)	Cost. (12)	Weight (13)	Cost. (14)	Weight (15)	Cost. (16)	Weight (17)	Cost. (18)	Weight (19)	Cost. (20)			
ompany (*Continued.*)												
Kgr.	*e*		*e*	Kgr.	*e*	Kgr.	*e*	Kgr.	*e*	Tons.	*f*	*a*), *b*), *c*), *d*), *e*), *f*). — See page $\frac{1847}{147}$
.076	...	...	...	27.560	...	25.780	...	... 213.35	...	1 805 096 24 600	...	
.068	...	...	...	26.807	...	23.120	...	... 111.62	...	31 407 930 22 345 163	...	
.069	...	...	...	41.428	...	29.880	...	... 232.92	...	11 892 428 584 870	...	
.063	...	...	...	46.317	...	39.400	. .	...	...	1 076 250	...	
...	...	...	...	...	...	...	...	160.59	...	505 050	...	
.051	...	...	...	30.732	...	27.200	...	... 170.69	...	15 412 940 124 860	...	
...	...	...	...	...	...	...	...	177.85	...	3 266 890	...	
...	...	...	...	...	...	...	...	... 82.89	...	5 860 8 576 996	...	
.165	...	...	...	20.942	...	19.900	...	... 125.38	...	12 303 907 1 830 170	...	
.148	...	...	...	20.273	...	17.030	...	... 100.08	...	2 925 420 26 951 324	...	
.036	...	...	...	29.467	...	26.780	...	...	...	37 794 392	...	
...	...	...	...	...	...	...	...	... 140.00	...	32 960 58 204 826	...	
.075	. .	...	...	24.202	...	22.990	...	... 138.71	...	57 365 824 5 553 870	...	

TABLE II. (*Continued*).

Designation of the class of locomotive according to the consumption per square metre of grate area per hour : A = Consumption exceeding 600 kgr. B = — between 400 and 600 kgr. C = — — 200 and 400 kgr. D = — below 200 kgr. E = Other types. (1)	Type of firebox. (2)	Approximate class according to hourly consumption. (3)	Consumption per kilometre per square metre of grate area. (4)	Number of locomotives in each class. (5)	Number of kilometres run in 1922 by the whole of the locomotives in each class (including light running) (6)	Number of hours of shunting, or corresponding number of kilometres, in 1922. (7)	Nature of fuel used (including liquid or powdered fuel). Nature of mixture, where used. (8)	Average depth of fire. (9)	Vacuum in smokebox for a given standard (10)
Eastern Railway									
a-c	*b*	*c*	Kgr.		*Explanation.* R. = Route. G. = Station.		*d*		
Series X 0-3-0	...	C	9.487	19	R. 289 735 G. 22 467	4 623.20 3 251.20	Mixture B.	...	...
Series XII. 1-4-0	...	C	9.411	35	R. 1 168 230	5 249.40	Mixture A.	...	...
Series III 0-2-1	...	B	9.374	25	R. 405 430 G. 3 759	3 459.30 578.00	Mixture B.	...	...
Series XII. 1-4-0	...	C	9.124	210	R. 4 937 479 G. 39 916	17 971.50 5 161.10	Mixture A.	...	...
Series VIII (tank-engines). 0-3-1	...	C	9.066	35	R. 861 290 G. 7 827	7 081.00 1 276.00	Mixture B.	...	...
Series IV 0-2-1	...	B	8 860	44	R. 762 801 G. 6 802	4 463.20 940.00	Mixture B.	...	...
Series VIII 1-3-0	...	B	8.651	48	R. 995 227 G. 132	10 507.30 22.00	Mixture B.	...	...
Series XII. 1-4-0	...	C	8.461	175	R. 5 483 866	10 288.10	Mixture A.	...	...
Series VIII (tank-engines) 2-3-0	...	B	8.447	50	R. 435 933 G. 562 633	3 879.30 89 252.20	Mixture B.	...	...
Series XI (tank-engines). 2-3-2	...	B	8.172	40	R. 888 404 G. 2 500	4 405.40 231.40	Mixture B.	...	...
Series VIII 1-3-0	...	B	8.131	68	R. 2 003 629 G. 40 955	12 187.20 6 150.30	Mixture B.	...	...
Series XI 2-3-0	...	C	7.805	180	R. 2 943 384 G. 126 707	16 679.30 19 082.50	Mixture B.	...	...
Series XI 2-3-0	...	C	7.765	25	R. 463 827	1 492.30	Mixture B.	...	...

TABLE II. (*Continued*).

Consumption and net cost (including cost of transport and handling) in 1922.										Total weight consumed in 1922 by the whole of the locomotives in each class.	How often is coal put on the locomotive (tender or bunker)?	*Remarks.*
per ton-kilometre.		per virtual ton-kilometre.		per train-kilometre.		per locomotive-kilometre.		per shunting hour.				
Veight (11)	Cost. (12)	Weight (13)	Cost. (14)	Weight (15)	Cost. (16)	Weight (17)	Cost. (18)	Weight (19)	Cost. (20)	(21)	(22)	(23)
Company. (*Continued*).												
Kgr.	*e*		*e*	Kgr.	*e*	Kgr.	*e*	Kgr.	*e*	Tons.	*f*	*a*) *b*) *c*) *d*) *e*) *f*), see page $\frac{1847}{147}$
.063	...	...	...	25.549	...	24.570	...	... 139.54	...	7 117 280 514 360	...	
.037	...	...	...	32.900	...	29.740	...	...	...	34 741 395	...	
.135	...	...	...	15.075	...	15.280	...	... 129.34	...	6 195 013 77 882	...	
.033	...	...	...	29.352	...	27.280	...	... 215.24	...	134 719 365 1 327 250	...	
.075	...	...	...	17.665	...	16.500	...	... 186.48	...	14 211 640 239 780	...	
.109	...	...	...	15.337	...	15.150	...	... 155.17	...	11 557 760 163 460	...	
.099	...	...	...	18.230	...	17.820	...	... 147.27	...	17 731 836 3 240	..	
.028	...	...	...	25.413	...	23.690	...	...	...	129 930 225	...	
.088	...	...	...	19.874	...	19.090	...	... 127.37	...	8 323 842 11 787 360	...	
.075	. .	...	...	22.178	...	21.000	...	... 166.09	...	18 655 220 56 430	...	
074	...	...	...	16.946	...	16.750	...	... 123.12	...	33 553 563 816 010	...	
.060	...	...	...	20.110	...	19.590	...	... 146.56	...	57 653 912 3 028 560	...	
.063	...	...	...	21.585	...	20.810	...	...	...	9 653) 46	...	

Table II. (*Continued.*)

Designation of the class of locomotive according to the consumption per square metre of grate area per hour : A = Consumption exceeding 600 kgr. B = — between 400 and 600 kgr. C = — — 200 and 400 kgr. D = — below 200 kgr. E = Other types. (1)	Type of firebox. (2)	Approximate class according to hourly consumption. (3)	Consumption per kilometre per square metre of grate area. (4)	Number of locomotives in each class. (5)	Number of kilometres run in 1922 by the whole of the locomotives in each class (including light running). (6)	Number of hours of shunting, or corresponding number of kilometres, in 1922. (7)	Nature of fuel used (including liquid or powdered fuel). Nature of mixture, where used. (8	Average depth of fire. (9)	Vacuum in smokebox for a given standard (10)
							Eastern Railwa		
a — c	*b*	*c*	Kgr.		*Explanation*, R. = Route. G. = Station.		*d*		
Series XII 1-5-0	...	C	7.707	9	R. 333 226	1 487.40	Mixture A.	...	
Series VIII (locomotives with large driving wheels) 2-2-1	...	B	7.661	2	R. 15 786	75.10	Mixture B.	...	
Series XI 2-3-0	...	B	7.318	210	R. 6 003 154 G. 204 140	30 268.00 25 428.20	Mixture B.	...	
Series VIII (locomotives with large driving wheels) 2-2-0	...	B	6.976	32	R. 686 214 G. 5 004	4 233.50 578.30	Mixture B.	...	
Series VIII (locomotives with large driving wheels) 2-2-1	...	B	6.923	10	R. 146 064	498.00	Mixture B.	...	
Series IV 1-2-0	...	B	6.678	44	R. 954 047 G. 330	6 212.40 24.00	Mixture B.	...	
Series XI 2-3-0	...	B	6.409	100	R. 3 367 514	5 027.30	Mixture B.	...	
Series XI (locomotives with large driving wheels). 2-3-0	...	C	6.021	17	R. 404 697	1 319.00	Mixture B.	...	
Series XI (locomotives with large driving wheels) 2-3-0	...	C	6.018	3	R. 67 598	23.40	Mixture B.	...	
Series VIII (locomotives with large driving wheels) 2-2-1	...	C	4.815	4	R. 90 632	337.30	Mixture B.	...	
Série XI (locomotives with large driving wheels) 2-3-0	...	C	4.705	130	R. 7 225 479	1 593.00	Mixture A.	...	
Series XI (« Pacific » locomotives) . . 2-3-1	...	C	4.119	28	R. 1 424 955	70.00	Mixture A.	...	

TABLE II. (*Continued*)

Consumption and net cost (including cost of transport and handling) in 1922.										Total weight consumed in 1922 by the whole of the locomotives in each class.	How often is coal put on the locomotive (tender or bunker)?	*Remarks.*
per ton-ilometre.		per virtual ton-kilometre.		per train-kilometre.		per locomotive-kilometre.		per shunting hour.				
ight	Cost.	Weight	Cost.	Weight	Cost.	Weight	Cost.	Weight	Cost.			
1)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)

npany (*Continued.*)

r.	e		e	Kgr.	e	Kgr.	e	Kgr.	e	Tons.	f	a), b), c), d), e), f). — See page $\frac{1847}{147}$
51	...	...	...	38.250	...	34.680	...	...	..	11 556 620	...	
93	...	...	...	21.151	...	20.990	...	...	...	331 290	...	
58	...	...	...	19.522	...	18.730	...	... 140.30	...	112 458 959 4 458 442	...	
74	...	...	. .	17.929	...	17.580	...	... 159.75	...	12 063 730 116 600	...	
102	...	...	...	19.180	...	18.760	...	...	...	2 740 590	...	
118	...	...	...	16.167	...	15.960	...	...	...	15 229 049 3 300	...	
48	...	...	...	17.031	...	16.470	...	...	...	55 468 358	...	
110	...	...	...	19.910	...	19.690	...	...	...	7 966 526	...	
63	...	...	...	17.170	...	17 090	...	...	...	1 155 550	...	
66	...	...	...	19.481	...	19.210	...	...	...	1 740 910	...	
039	...	...	...	14.927	...	14.870	...	...	...	107 425 823	...	
38	...	...	...	17 574	...	17.590	...	...	...	25 067 132	...	

Table II. (*Continued.*

Designation of the class of locomotive according to the consumption per square metre of grate area per hour : A = Consumption exceeding 600 kgr. B = — between 400 and 600 kgr. C = — — 200 and 400 kgr. D = — below 200 kgr. E = Other types.	Types of firebox.	Number of locomotives in each class.	Number of kilometres run in 1922 by the whole of the locomotives in each class (including light running).	Number of hours of shunting or corresponding number of kilometres, in 1922.	Nature of fuel used (including liquid or powdered fuel.) Nature of mixtures, where used.	Average depth of fire.	Vacuum in smokebox for a given standard of firing.	Consump per ton-kilometre.	
								Weight.	Co
								Midi Rail	
								Kilogr.	Fra
Type B.	Ordinary firebox with firebars.	544	..	...	...	...	...	0.3074	0.
Type C.	Ordinary firebox with firebars or with rocking grate.	628	...	. .	...	...	...		
								Paris-Orl	
			Kilometres.	Kilometres.				Kilogr.	Fra
Whole railway. Results for 1922	...	...	66 478 000 including 1 271 000 by electric locomotives.	1 120 200	Small, large and briquettes.	...	...	0.07	0.
								Paris-Lyons-Med	
			Kilometres.	Kilometres.		Cm.			
Type B.	Crampton, Belpaire, Wooten, Crampton type with round topped firebox.	3437	120 874 995 for the whole of the railway.	15 147 911 for the whole of the railway.	Briquettes, screened, small, rough.	30 to 50	...	...	.
Shunting engines.	Crampton.	215	...	...	...	...	...	...	.
	Belpaire.	34	...	...	...	...	...	...	.
								Chalosse and B	
			Km.-locomot.	Kilometres.					
Corpet engines	Belpaire.	7	143 384	3 475	Cardiff rough.	0.25	...	...	.
Superheater engines	Belpaire.	2	48 245						

TABLE II. (*Continued.*)

and net cost (including cost of transport and handling) in 1922								Total weight consumed in 1922 by the whole of the locomotives in each class.	How often is coal put on the locomotive (tender or bunker)?	*Remarks.*
per virtual ton-kilometre		per train-kilometre.		per locomotive-kilometre.		per shunting hour.				
Weight.	Cost.	Weight.	Cost.	Weight.	Cost.	Weight	Cost.			
Company.										
		Kilogr.	Francs.	Kilogr.	Francs.					
...	...	23.197	2.39	17.940	1.85	...	...	...	...	
Railway Company.										
		Kilogr.	Francs.	Kilogr.	Francs.	Kgr.	Francs.	Tons.		
...	...	25.620	2.61	21.140	2.15	100	10.21	1 378 700	...	
ranean Railway Company.										
		Kilogr.	Francs.	Kilogr.	Francs.	Kgr.	Francs.			
...	...	6.284	0.713	19.806	2.666	...	...	...	...	
...	...	...	...	...	...	116.30	12.24	...	...	
...	...	...	...	...	...	134.73	14.34	...	...	
Steam Tramways.										
								Tons.		
...	...	...	...	...	...	...	...	2 344	...	

TABLE II. (*Continued*).

Designation of the class of locomotive according to the consumption per square metre of grate area per hour : A = Consumption exceeding 600 kgr. B = — between 400 and 600 kgr. C = — — 200 and 400 kgr. D = — below 200 kgr. E = Other types.	Types of firebox.	Number of locomotives in each class.	Number of kilometres run in 1922 by the whole of the locomotives in each class (including light running).	Number of hours of shunting or corresponding number of kilometres, in 1922.	Nature of fuel used including liquid or powdered fuel.) Nature of mixtures, where used.	Average depth of fire.	Vacuum in smokebox for a given standard of firing.	Consumptio per ton-kilometre.	
								Weight.	Cost.
Railways of th									
			Kilometres.	Hours.				Kgr.	Francs.
Locomotives of 18 t. weight light.	...	7	112 000	3 200	Coal and briquettes.	...	...	0.425	0.070
Locomotives of 22 t. weight light.	...	7	142 000	1 100		...	...	0.285	0.035
Landes Loca									
			Kilometres.						
Locomotives 1 to 12 (Landes): grate area 0 m² 84	...	...	595 650	...	...	...	...	...	...
Locomotives 21 to 24 (Born and Marensin); grate area 1 m². .	...	...							
Railways of th									
			Kilometres.					Kgr.	Francs.
Type C.	...	2	39 763	1 030 h. or 4 128 km.	Washed small and briquettes.	...	...	0.290	0.033
Type D.	...	4	80 913	1 193 h. or 5 036 km.	Washed small and briquettes.	...	...	0.210	0.024
Algerian Stat									
			Kilometres.	Kilometres,				Kgr. (1)	Francs
Type C	Copper.	318	9 662 201	769 776	Coal and briquettes.	10 to 20 cm.	...	0.099	0.020

TABLE II. (*Continued*).

d net cost (including cost of transport and handling) in 1922								Total weight consumed in 1922 by the whole of the locomotives in each class.	How often is coal put on the locomotive (tender or bunker)?	*Remarks.*
per virtual ton-kilometre		per train-kilometre.		per locomotive-kilometre.		per shunting hour.				
Weight.	Cost.	Weight.	Cost.	Weight.	Cost.	Weight	Cost.			
arn Département.										
		Kgr.	Francs.			Kgr.	Francs.	Tons.		
...	...	12.8	1.60	...	...	50	6.25	1 435	...	
..	...	11.5	1.50	...	...	50	6.25	1 640	...	
ilways.										
...	...	...	...	...	...	...	...	...	...	
stern Pyrenees.										
Kgr.	Francs.	Kgr.	Francs.	Kgr.	Francs.	Kgr.	Francs.	Tons.		
0.290	0.033	19.011	2.15	13.233	1.56	55.332	6.25	666	1 per day.	
0.210	0.024	9.998	1.13	8.416	0.95	33.664	3.80	672	1 per day.	
ilways.										
		Kgr.	Francs.	Kgr.	Francs.	Kgr.	Francs.	Tons.		
...	...	17.748	3.61	12.700	2.58	90	18.[illegible]5	112 198.529	3 to 4 times per 1 000 km.	(1) The net cost per ton-kilometre is that of the ton hauled (weight of the engine and tender not included).

TABLE II. (*Continued.*)

Designation of the class of locomotive according to the consumption per square metre of grate area per hour : A = Consumption exceeding 600 kgr. B = — between 400 and 600 kgr. C = — — 200 and 400 kgr. D = — below 200 kgr. E = Other types.	Types of firebox.	Number of locomotives in each class.	Number of kilometres run in 1922 by the whole of the locomotives in each class (including light running).	Number of hours of shunting or corresponding number of kilometres, in 1922.	Nature of fuel used (including liquid or powdered fuel.) Nature of mixtures, where used.	Average depth of fire.	Vacuum in smokebox for a given standard of firing.	Consump per ton-kilometre. Weight.	Cos
								Tunisian Rail	
Standard gauge.		In service.		Kilom.		Cm.		Kgr.	Milli
B. Series 81. American	Firebox with round top and direct stays, and fixed between the frames.	1	39 483	1 817	Briquettes.	18	...	0.120	13.
C. Series 221	Belpaire fixed between the frames, with crown stays.	6	130 996	12 789	Ditto.	18	...	0.070	8.
— 181		5	238 658	...	Ditto.	18	...	0.084	9.
D. Series 1 transformed	Ditto.	17	559 274	45 639	Ditto.	16	...	0 069	8.
Narrow gauge.									
C. Series 301	Firebox fixed between the frames with round top and roof bars.	8	79 708	9 744	Ditto.	17	...	0.126	14.
— 351			96 659	10 157	Ditto.	17	...	0.520	14.
— 451	Belpaire fixed between the frames, with crown stays.	28	987 454	75 089	Ditto.	20	...	0.014	5.
— 501	Ditto.	4	225 139	1 960	Ditto.	15	...	0.088	10.
— 551	Ditto.	47	1 249 512	114 520	Ditto.	25	...	0.042	4.
— 701	Ditto.	9	406 904	7 959	Ditto.	15	...	0.104	12.
— 751	Ditto.	4	148 084	917	Ditto.	15	...	0.107	12.
— 801	Ditto.	3	161 499	2 464	Ditto.	30	...	0.072	8.
D. Series 401	Firebox fixed between the frames with round top and roof bars.	13	387 376	76 965	Ditto.	20	...	0.109	12.
— 1021	Ditto with direct stays.	1	44 109	44 109	Ditto.	15	...	...	..
— 1	Ditto with roof bars.	4	87 418	59 752	Ditto.	15	...	0.085	9.
— 2001	Ditto with direct stays.	2	7 369	...	Ditto.	12	...	0 119	13.
— 681	Ditto.	3	69 493	518	Briquettes and mazout, 9/10 briq. 1/10 mazout.	25	...	0.041	4.

Table II. (*Continued.*)

net cost (including cost of transport and handling) in 1922								Total weight consumed in 1922 by the whole of the locomotives in each class.	How often is coal put on the locomotive (tender or bunker)?	*Remarks.*
per virtual on-kilometre		per train-kilometre.		per locomotive-kilometre.		per shunting hour.				
eight.	Cost.	Weight.	Cost.	Weight.	Cost.	Weight	Cost.			
mpany.										
		Kgr.	Millimes.	Kgr.	Millimes.	Kgr.	Millimes.	Tons.	Per month and per engine.	
...	...	13.55	1 585.97	13.30	1 556.4	8.06	943.4	525.046	42	Tank engine.
...	...	22.63	2 649.13	22.57	2 642.06	19.48	2 276.16	2 957.050	33	Engines with separate tender,
...	...	15.60	1 826.28	15.60	1 826.28	...	...	3 724 000	20	
...	...	10.20	1 193.44	10.26	1 200.44	9.73	1 138.24	5 736.310	30	Tank engine.
...	...	7.18	840.3	7.28	851.6	7.88	921.9	579.950	24	Tank engine.
...	...	7.31	855.7	7.59	888.3	8.62	1 009.4	723.600		
...	...	9.44	1 105.2	9.96	1 165.9	13.86	1 622.1	9 836.460	30	Ditto.
...	...	9.65	1 129.9	9.70	1 135.4	13.78	1 612.3	2 184.000	22	Engines with separate tender.
...	...	16.04	1 877.5	16.25	1 901.8	16.49	1 930.2	20 302.582	28	Tank engine.
...	...	11.02	1 290 3	11.28	1 320.5	14.43	1 688.5	4 590.750	22	Engines with separate tender.
...	...	8.62	1 009.2	9.05	1 059.0	11.62	1 360.6	1 339.950	31	Ditto.
...	...	10.23	1 197.0	10.27	1 202.6	12.54	1 467.8	1 659.400	24	Ditto.
...	...	7.85	918.6	8.31	972.3	10.16	1 189.2	3 218.580	24	Tank engine.
...	...	...	...	7.25	848.0	7.25	848.0	319.600	40	Ditto.
...	...	9.99	1 169.7	8.00	936.8	7.08	828.9	699.700	25	Ditto.
...	...	8.73	1 021.3	8.73	1 021.3	...	...	64.300	9	Ditto.
...	...	16.44	1 924.2	16.41	1 920.9	11.78	1 378.3	1 140.500	28	Ditto.

Table II. (*Continued*.)

Designation of the class of locomotive according to the consumption per square metre of grate area per hour : A = Consumption exceeding 600 kgr. B = — between 400 and 600 kgr. C = — — 200 and 400 kgr. D = — below 200 kgr. E = Other types.	Types of firebox.	Number of locomotives in each class.	Number of kilometres run in 1922 by the whole of the locomotives in each class (including light running).	Number of hours of shunting or corresponding number of kilometres, in 1922.	Nature of fuel used (including liquid or powdered fuel.) Nature of mixtures, where used.	Average depth of fire.	Vacuum in smokebox for a given standard of firing.	Consum	
								per ton-kilometre.	
								Weight.	Co
					Franco-Ethio				
Type C.			Kilometr. s.	Hours.		Cm.			Fra
1. Simple locomotive (6 coupled). Weight in working order, 53 t. .	...	6	1 729	...	Briquettes.	0.15	0.060	0 kgr. 31	0.
			10 323	...	Wood.	0.40		0 m^3.0022	0.0
					Lighting wood.	...	...	...	.
2. Superheated steam locomotive (6 coupled), with tender. Weight in working order, 53 t. .	...	3	66 033	...	Briquettes.	0.20	0.070	0 kgr.081	0.
					Lighting wood.	...	...	...	.
3. Compound locomotive (8 coupled). Weight in working order, 59 t. 3.	...	13	103 191	...	Briquettes.	0.15	0.050	0 kgr.094	0.
			23 856	...	Wood.	0.50		0 m^3 063	0.
					Lighting wood.	...	...	...	.
4. Superheated steam locomotives (8 coupled). Weight in working order, 60 t. 3.	...	8	...	...	Briquettes.	0.20	0.080	0 kgr.072	0.
					Lighting wood.	...	...	...	.
Type D.									
1. Tank engines, 2 cylinder (6 coupled). Weight in working order, 26 t. .	...	8	18 897	5 000	Briquettes.	0.15	0.060	...	.
			19 568		Wood.	0.40	0.060	0 m^3 094	0.7
					Lighting wood.	...	...	...	.
3. Tank engines, 2 cylinder (6 coupled). Weight in working order, 26 t. 9.	...	1	1 280	1 500	Briquettes.	0.15	0.060	...	.
					Lighting wood.	...	...	...	.
					General Administration of Railways and pu				
						Cm.		Kilogr.	Fra
Type C	Ordinary firebox of copper.	16	313 205	...	Cardiff briquettes.	25	...	0 40	0.0
Type D.	Ditto.	10	272 617	...	Ditto.	15	...	0.15	0.0
Type B.	Ditto.	9	335 674	...	Cardiff best coal.	20	...	0.077	0

TABLE II. (*Continued.*)

nd net cost (including cost of transport and handling) in 1922								Total weight consumed in 1922 by the whole of the locomotives in each class.	How often is coal put on the locomotive (tender or bunker)?	*Remarks*
per virtual ton-kilometre		per train-kilometre.		per locomotive-kilometre.		per shunting hour.				
Weight.	Cost.	Weight.	Cost.	Weight.	Cost.	Weight	Cost.			
Railway.										
	Francs.		Francs.		Francs.	Kgr.	Francs.			
0 kgr. 16	0.04	1 kgr. 75	4.37	4 kgr. 5	1.12	...	...	30 300 kgr.	...	Weight and average cost per ton-kilometre : *Briquettes :* 0 kgr. 08 — 0 fr. 02. *Wood :* 0 m^3 0014 — 0 fr. 011.
0 m^3 0001	0.0008	0 m^3 108	0.86	0 m^3 022	0.17	...	...	1 115 m^3	...	
...	...	...	...	...	...	...	...	128 m^3	...	
0 kgr.055	0.013	9 kgr. 23	2.30	4 kgr.	1.00	...	...	614 942 kgr.	...	
...	...	...	...	...	...	...	...	38 m^3 5	...	
0 kgr. 06	0.015	12 kgr.5	3.12	5 kgr. 5	1.22	...	...	1 291 000kgr.	...	
0 m^3 0004	0.0032	0 m^3 06	4.80	0 m^3 027	0.22	...	...	1 522 m^3	...	
...	...	...	...	...	...	...	...	494 m^3	...	
0 kgr.051	0.012	10 kgr. 9	2.72	5 kgr.	1.00	...	...	1 766 800kgr.	...	
...	...	...	...	...	...	...	...	358 m^3	...	
...	...	...	...	...	...	25	6.25	126 300 kgr.	...	
0 m^3 0013	0.0104	0 m^3 70	5.60	0 m^3 0175	0.14	...	...	1 844 m^3	...	
...	...	...	...	...	...	...	...	30 m^3	...	
...	...	...	...	3 kgr. 5	0.62	25	6.25	39 050 kgr.	...	
...	...	...	...	...	...	...	...	60 m^3	...	
works (Damascus-Hamah and extensions).										
		Kilogr.	Francs.	Kilogr.	Francs.	Kgr.	Francs.	Tons.		
...	...	28	5.60	11	2.06	80	16	9.073	10	
...	...	12	2.40	4.2	0.84	70	14	2 814	5	*D.* Shunting kilometres are to be deducted from the total ; also 731 tons of coal used in shunting operations.
...	...	16	2.40	4.5	0.67	80	12	5 262	5	*B.* Shunting kilometres are to be deducted from the total ; also 223 tons of coal used in shunting operations.

TABLE II. (*Continued*).

Designation of the class of locomotive according to the consumption per square metre of grate area per hour : A = Consumption exceeding 600 kgr. B = — between 400 and 600 kgr. C = — — 200 and 400 kgr. D = — below 200 kgr. E = Other types.	Types of firebox.	Number of locomotives in each class.	Number of kilometres run in 1922 by the whole of the locomotives in each class (including light running).	Number of hours of shunting or corresponding number of kilometres, in 1922.	Nature of fuel used (including liquid or powdered fuel.) Nature of mixtures, where used.	Average depth of fire.	Vacuum in smokebox for a given standard of firing.	Consumpt per ton-kilometre. Weight.	Cost
General Administration of Railways and Pul									
						Cm.		Kilogr.	Poun
Type C	...	47	1 251 930	147 461	Cardiff, Heraclea, American.	20	...	0.079	0.1
Type D.	...	5	71 306	71 306	Heraclea, Lignite.	20	...	...	...
French West Africa.									
						Cm.		Grammes.	
Type D. 13 locomotives of 30.030 t.	...	19	79 626	Engaged in shunting operations	Grand-Combe briquettes and wood for lighting.	15	...	60	...
Type D. 4 ditto of 18.020 t.	...		15 800			10	...	...	...
Type D. 2 ditto of 37.230 t.	...		14 322			15	...	60	...
French West Africa									
			Kilometres.					Grammes.	
Type D. 4 locomotives of 12 t.. . .	...	8	34 729	...	Briquettes and wood.	...	...	60	...
Type D. 3 ditto of 20 t.. . .	...		27 631	...		...	...		...
Type D. 1 ditto of 32 t.. . .	....		...	...		...	...		...
Kayes-Ni									
			Kilometres.					Kgr.	(1)
Type C : 47 tons	...	1	3 365	...	Coal.	...	...	0.200	...
					Wood.	...	...	...	...
Type D 27 tons	...	2	94 274	...	Coal.	...	...	0.140	...
					Wood.	...	...	...	...
Type D 26 tons	...	11	325 399	...	Coal.	...	...	0.140	...
					Wood.	...	...	...	...
Type D 18 tons	...	7	250 843	...	Coal.	...	...	0.097	...
					Wood.	...	...	...	...
Type D 15 tons	...	8	113 541	...	Coal.	..	...	0.100	...
					Wood.	...	...	...	...
Type D 10 tons	...	2	31 481	...	Coal.	...	...	0.100	...
Type D 10 tons	..	2	...	...	Wood.	...	...	...	...
Type E : Rail motor car	...	1	768	...	Coal.	...	...	...	...

TABLE II. (*Continued.*)

net cost (including cost of transport and handling) in 1922								Total weight consumed in 1922 by the whole of the locomotives in each class.	How often is coal put on the locomotive (tender or bunker)?	*Remarks.*
per virtual on-kilometre		per train-kilometre.		per locomotive-kilometre.		per shunting hour.				
eight.	Cost.	Weight.	Cost.	Weight.	Cost.	Weight.	Cost.			
orks (Smyrna-Cassaba and Extensions).										
ilogr.	P.	Kilogr.	P.	Kilogr.	P.	Kgr.	P.	Tons.		
.125	0.23	18.05	33.98	16	20.12	120	226	21 171	...	Cardiff . . . . . 17 300 tons. Heraclea . . . . 2 726 — American . . . 356 —
...	...	...	...	...	...	110.6	147	789	...	Heraclea . . . . . 574 — Lignite . . . . . 215 —
homey Railways.										
		Kilogr.				Kgr.		Tons.		
...	...	10.100	...	...	...	40.96	...	1 440	5 to 8	
...	...	8.000	...	...	...		...			
...	...	10.100	...	...	...		...			
homey Eastern Railways.										
		Kilogr.								
...	...	Coal 1.280	..	...	...	...	...	...	5 to 8	
..	...		...	...	...	...	...	...		
...	...	Wood 15.385	...	...	...	...	...	...		
ilway.										
Kgr.	(1)	Kgr.	(1)		(1)	Kgr.	(1)	Tons.		
.400	...	10	...	...	...	10	...			
...	...	...	...	...	...	25	...			
.280	...	7	...	...	...	7	...			
...	...	...	...	...	...	25	...			
.280	...	7	...	...	...	7	...	Coal,		
...	...	...	...	...	...	25	...	1 764		Mixed combustion has frequently been resorted to (5/6 wood, 1/6 coal).
.185	...	5.5	...	...	...	5.5	...	Wood	...	
...	...	...	...	...	...	25	...	8 000		
.200	...	4.5	...	...	...	4.5	...			
...	...	...	...	...	...	20	...			
.200	...	4	...	...	...	4	...			
...	...	...	...	...	..	20	...			
...	...	3	...	...	...	...	...	7 680		

TABLE II (*Continued.*)

Designation of the class of locomotive according to the consumption per square metre of grate area per hour : A = Consumption exceeding 600 kgr. B = — between 400 and 600 kgr. C = — — 200 and 400 kgr. D = — below 200 kgr. E = Other types.	Types of firebox.	Number of locomotives in each class.	Number of kilometres run in 1922 by the whole of the locomotives in each class (including light running).	Number of hours of shunting or corresponding number of kilometres, in 1922.	Nature of fuel used including liquid or powdered fuel.) Nature of mixtures, where used.	Average depth of fire.	Vacuum in smokebox for a given standard of firing.	Consum	
								per ton-kilometre.	
								Weight.	Co
Konakry-N									
			Kilometres.						
Type C.	...	34	498 598	...	Wood. Coal.	... ...	... ...	... ...	0.
Reggio-E									
				Km.		Cm.		Kgr.	
Type D (consumption 170 kgr.)	...	6	155 008	41 800	Cardiff anthracite.	15	...	0.044	0.0
Type C (consumption 240 kgr.)	...	5	70 000	30 000	Ditto.	15	...	0.046	0.0
Railways of the Japa									
			Km.			Mm.			
(1)	...	..	155 323 243	...	Coal.	150	...	...	
Prince E									
						Cm.			
This classification is not adopted by these railways	...	...	...	...	...	25 to 30	...	...	
D									
						Cm.			
Type A.	...	733	34 871 909	4 760 450	Coal.	40	...	...	
Type B.	...	229	8 078 323	1 952 740	Ditto.	40	...	...	
Type C.	...	360	13 069 214	6 079 100	Ditto.	40	...	...	
Type D.	...	132	5 459 606	5 342 130	Ditto.	40	...	...	

TABLE II. (*Continued*).

and net cost (including cost of transport and handling) in 1922								Total weight consumed in 1922 by the whole of the locomotives in each class.	How often is coal put on the locomotive (tender or bunker)?	*Remarks.*
per virtual ton-kilometre		per train-kilometre.		per locomotive-kilometre.		per shunting hour.				
Weight.	Cost.	Weight.	Cost.	Weight.	Cost.	Weight	Cost.			
ailway.										
								Tons.		
...	0.031	...	...	...	0.88	...	...	22 179	...	The average cost of a ton of coal in 1922 was 570 francs. A ton of wood costs less than 15 francs. A ton of coal can be replaced by 75 francs' worth of wood.
...	...	...	...	...	...	...	...	192	...	
ailway.										
Kgr.	L.	Kgr.	L.	Kgr.	L.	Kgr.	L.	Tons.		
0.037	0.0095	8.400	2.025	8.80	2,20	60	15	2 000	...	
0.038	0.009	8.400	2.025	8.80	2.20	117	29.25			
mperial Government										
		Kgr.	Yen.	Kgr.	Yen.	Kgr.	Yen.	Tons.		
...,	...	0.376	0.005	21.65	0.256	17.35	0.211	2 695 764.6	...	(1) The weight consumed and the kilometres run are in respect of the whole of the locomotives.
ailways and Mines										
				K.						
...	...	...	...	19.55	...	...	...	...	...	
ailways										
					Florins.					
...	...	...	...	13.68	0.27	...	...	477 208	...	
...	...	...	...	14.77	0.29	...	...	119 290	...	
...	...	...	...	9.35	0.18^4	...	...	122 254	...	
...	...	...	...	7.28	0.14^3	...	...	39 759	...	

TABLE II. (*Continued.*)

Designation of the class of locomotive according to the consumption per square metre of grate area per hour : A = Consumption exceeding 600 kgr. B = — between 400 and 600 kgr. C = — — 200 and 400 kgr. D = — below 200 kgr. E = Other types.			Types of firebox.	Number of locomotives in each class.	Number of kilometres run in 1922 by the whole of the locomotives in each class including light running.	Number of hours of shunting or corresponding number of kilometres, in 1922.	Nature of fuel used including liquid or powdered fuel.) Nature of mixtures, where used.	Average depth of fire.	Vacuum in smokebox for a given standard of firing.	Consumptio	
										per ton-kilometre.	
										Weight.	Cost.
										Dutch East India	
Consumption in kilogrammes of wood, 1.8 kgr. of wood = 1 kgr. of coal.								Cm.			
Locomotives for 1.435 m. gauge.											
Type.	Company's number.	Consumption.	Copper firebox.								
	A (1)		Grate :								
2 C II*t*β	81/86	895	Inclined.	6	216 000	26 000	Wood.	50	...	...	...
B 1 II*t*β	10/33	855	Ditto.	15	508 400	120 000	Ditto.	70	...	...	...
2 C II T*a*	89/94	675	Ditto.	6	293 000	17 800	Ditto.	70	...	...	...
2 C II T*a*	87/88	610	Ditto.	2	124 700	1 600	Ditto.	50	...	...	...
	B										
1 D II T*a*	61/64	510	Inclined.	4	184 300	1 200	Ditto.	80	...	...	...
1 C 1 II*ta*	51/57	450	Ditto.	7	281 800	4 800	Ditto.	60	...	...	...
Locomotives for 1.067 m. gauge.											
	B										
2 C II T*a*	371/400	445	Inclined.	25	805 000	69 400	Wood.	50	...	...	...
C II*ta*	250/263	428	Horizontal.	13	312 000	43 500	Ditto.	50	...	...	...
C 1 II*ta*	351/360	410	Inclined.	10	265 800	43 200	Ditto.	60	...	...	...
	C										
1 B II*ta*	331/339	390	Horizontal.	9	198 000	45 200	Ditto.	60	...	...	...
B 1 II*t*β	306/325	342	Ditto.	20	609 000	189 000	Ditto.	50	...	...	...
1 C 1 II T*a*	271/285	285	Inclined.	15	429 000	9 500	Ditto.	60	...	...	...
B I IV*t*β	231/235	260	Ditto.	5	78 500	6 600	Ditto.	50	...	...	...

TABLE II. (*Continued.*)

nd net cost (including cost of transport and handling) in 1922								Total weight consumed in 1922 by the whole of the locomotives in each class.	How often is coal put on the locomotive (tender or bunker)?	*Remarks.*
per virtual ton-kilometre		per train-kilometre.		per locomotive-kilometre.		per shunting hour.				
Weight.	Cost.	Weight.	Cost.	Weight.	Cost.	Weight	Cost.			
ailway Company.										
				Kgr.	Cents. (2)			(3)		(1) The figures 1 and 2 indicate the number of free axles. The capital letters indicate the number of coupled axles. II or IV = Number of cylinders. *t* = Saturated steam. T = Superheated steam. α = Two cylinder locomotive. β = Compound locomotives. (2) Ct = Cent = 0.01 florin. (3) The total tonnage exceeds the yearly consumption, because the consumption of coal is reduced to terms of consumption of wood by multiplying the consumption of coal by 1.8.
...	..	...	...	33.9	53.0	...	...	7 300	...	
...	...	...	...	23.52	36.7	...	...	12 000	...	
...	...	...	...	25.62	40.0	...	...	7 500	...	
...	...	...	...	23.32	36.4	...	...	2 900	...	
...	...	...	...	43.77	68.2	...	...	8 000	...	
...	...	...	...	30.04	47.0	...	...	8 500	...	
...	..	...	...	17.7	27.6	...	...	14 300	...	
...	...	...	...	19.34	30.0	...	...	6 000	...	
...	...	...	...	17.42	27.2	...	...	4 100	...	
...	...	...	...	11.33	17.6	...	...	2 200	...	
...	...	...	...	10.25	16.0	...	...	6 200	...	
...	...	...	...	25.63	40.0	...	...	11 000	...	
...	...	...	...	31.25	48.6	...	...	2 400	...	

TABLE II. (*Continued.*)

Designation of the class of locomotive according to the consumption per square metre of grate area per hour : A = Consumption exceeding 600 kgr. B = — between 400 and 600 kgr. C = — — 200 and 400 kgr. D = — below 200 kgr. E = Other types.	Types of firebox.	Number of locomotives in each class.	Number of kilometres run in 1922 by the whole of the locomotives in each class (including light running).	Number of hours of shunting or corresponding number of kilometres, in 1922.	Nature of fuel used (including liquid or powdered fuel.) Nature of mixtures, where used.	Average depth of fire.	Vacuum in smokebox for a given standard of firing.	Consumpt per ton-kilometre. Weight.	Cost.
Dutch East Indi									
Type :						Cm.			
C. 1C-II.	Ordinary firebox.	44	1 379 915	138 096	Coal or wood.	10	80	...	...
C. 1C-II-C.	Ditto.	78	2 841 022	84 288	Ditto.	10	80	...	...
C. B + B-IV-*c-à*	Ditto.	16	913 870	14 408	Ditto.	10	100	...	...
B. 1C + C-IV-*c-a*	Ditto.	44	1 486 905	16 488	Ditto.	15	120	...	...
B. 1F1-II-S	Ditto.	23	1 025 540	8 577	Ditto.	15	120	...	...
B. 1D + D-IV-C-*s-a-t.*	Ditto.	20	640 264	1 080	Ditto.	15	120	...	...
C. 2B-II-*c-t*	Ditto.	44	1 586 530	34 892	Ditto.	10	80	...	...
C. 2B-II-*s-t*	Ditto.	11	407 985	2 170	Ditto.	10	80	...	...
B. 2C2-II-*s* (series 1 100)	Ditto.	34	1 365 306	8 182	Ditto.	15	100	...	...
B. 2C2-II-*s* (series 1 300)	Ditto.	58	2 639 162	19 714	Ditto.	15	100	...	...
B. 2C1-IV-C-*s-t*	Ditto.	20	868 702	1 092	Ditto.	15	120	...	...
B. 1D-II-*s-t*	Ditto.	42	2 002 996	17 254	Ditto.	15	100	...	...
B. 1D1-II-*s*	Ditto.	24	587 983	31 234	Ditto.	15	100	...	...
B. 1D1-II-*s-t.*	Ditto.	10	343 929	10 541	Ditto.	15	120	...	...
D. Various types of small models.	Ditto.	78	1 995 856	205 214	Ditto.	10	60	...	...
B. 2C1-II-*s-t.*	Ditto.	16	750 183	2 782	Ditto.	15	100	...	...
Swedish Sta									
Type B.								Per axle-kilometre (	
Express and passenger train locomotives :									
1) Modern	...	170	9 490 000	...	...	...	...	0.503	0 099
2) Old	...	24	628 000	...	...	...	...	...	...
Type C.									
Goods train locomotives :									
1) Modern	...	246	7 950 000	...	...	...	...	0.404	0.025
2) Old	...	85	1 845 000	...	...	...	...	...	...
Suburban locomotives	...	110	4 427 000	...	...	...	...	0.801	0.035
Type D.									
Shunting engines :									
1) Modern	...	120	...	3 755 000	...	...	...	...	...
2) Old	...	3	...	27 000	...	...	...	...	...
Railways of the Czec									
						Mm.	Mm.		
Type B.	Rocking grate.	40	...	...	1/3 lignite, 2/3 coal.	250 to 300	100 to 140	...	...
Type B.	Ditto.	42	...	...	Lignite.	200 to 250	80 to 120	...	...
Type B.	Ditto.	30	...	...	Lignite.	250 to 300	80 to 120	...	...

TABLE II. (*Continued.*)

net cost (including cost of transport and handling) in 1922								Total weight consumed in 1922 by the whole of the locomotives in each class.	How often is coal put on the locomotive (tender or bunker)?	*Remarks.*
per virtual on-kilometre		per train-kilometre.		per locomotive-kilometre.		per shunting hour.				
eight.	Cost.	Weight.	Cost.	Weight.	Cost.	Weight	Cost.			
ilways. — Java.										
				Kilogr.	Florins.					
...	...	...	...	9.9	0.32	...	...	...	...	*Explanation* : *a* = Articulated locomotive. *c* = Compound. *s* = Superheater. *t* = Separate tender. II and IV = Number of cylinders.
...	...	...	...	11.3	0.40	...	...	...	...	
...	...	...	...	15.9	0.57	...	...	...	...	
...	...	...	...	17.3	0.62	...	...	...	...	
...	...	...	...	21.7	0.77	...	...	...	...	
...	...	...	...	32.8	1.09	...	...	...	...	
...	...	...	...	10.0	0.35	...	...	...	...	
...	...	...	...	12.3	0.51	...	...	...	...	
...	...	...	...	15.3	0.55	...	...	...	...	
...	...	...	...	14.8	0.53	...	...	...	...	
...	...	...	...	15.9	0.57	...	...	...	...	
...	...	...	...	17.4	0.62	...	...	...	...	
...	...	...	...	15.5	0.55	...	...	...	...	
...	...	...	...	17.5	0.63	...	...	...	...	
...	...	...	...	8.5	0.30	...	...	...	...	
...	...	...	...	14.2	0.51	...	...	...	...	
ailways.										(1) Price in Swedish crowns.
...	...	...	...	13.75	0.5247	...	...	...	...	
...	...	...	...	12.28	0.6541	...	...	...	...	
...	...	...	...	18.12	1.1341	...	...	...	...	
...	...	...	...	16.50	0.8877	...	...	...	...	
...	...	...	...	10.71	0.4842	...	...	...	...	
...	...	...	...	20.00	0.8537	...	...	...	...	
...	...	...	...	19.64	0.6836	...	...	...	...	
ovakian Republic.										
...	...	...	...	...	...	...	...	...	...	Fast train locomotives; superheater.
...	...	...	...	...	...	...	...	...	...	Goods train locomotives; superheater.
...	...	...	...	...	...	...	...	...	...	Tank engines for local lines.

CHAPTER II.

QUESTION *b.*

I. — *Fireboxes and grates* (see table 3).

II. — *Opinion as to the value :*

1° of the types of grate adopted;
2° of the types of firebox adopted.

III. — *Apparatus for the combustion of liquid fuel :*

1° Description;
2° Sketches or plans;
3° Results of tests;
4° Opinion upon the value of the apparatus used;
5° Advantages and disadvantages connected with the use of the various kinds of liquid fuel used on your railway. — Comparison between the net costs of the use of these kinds of fuel and the use of solid fuel, taking into account such factors as the locking up of capital, and charges for sinking fund, repairs, upkeep, etc., where such factors have not been allowed for in calculating the net costs shewn in table 2.

IV. — *Pulverised fuel. Apparatus.*

1° Description;
2° Sketches or plans;
3° Results of tests;
4° Opinion upon the value of the apparatus used;
5° Advantages and disadvantages connected with the use of the different kinds of pulverised fuel used on your railway. — Comparison between the net costs of the use of these kinds of fuel and the use of solid fuel, taking into account such factors as the locking up of capital, and charges for sinking fund, repairs, upkeep, etc., where such factors have not been allowed for calculating the net costs shewn in table 2.

QUESTION *c.*

Mechanical stoking arrangements.

1° Description;
2° Sketches or plans;
3° Results of tests;
4° Opinion upon the value of the apparatus used;
5° Advantages and disadvantages of mechanical stoking. Comparison between the net costs of this system and other systems of firing, allowing for all factors such as the locking up of capital, and charges for sinking fund, repairs, upkeep, etc.

QUESTION *d.*

I. — *Smoke consuming devices.*

1° Description;
2° Sketches or plans;
3° Results of tests;
4° Opinion as to the value of the apparatus used.

II. — *Utility of the various types of smoke consuming devices used, from the point of view of smoke consumption and of economy.*

III. — *Spark arresters.*

1° Description;
2° Sketches or plans;
3° Results of tests;
4° Opinion as to the value of the apparatus used.

N. B. — We regret that lack of space prevents us from reproducing the numerous plans and sketches which have been sent to us by a large number of the administrations consulted.

BELGIAN STATE RAILWAYS.

Question b.

II. — 1° The type of fixed grate most generally adopted is that which consists of groups of firebars made of wrought iron. Less frequently cast iron grates are used.

A very large number of locomotives are, however, fitted with toothed rocking grates. The use of this type of grate is increasing. Dump grates are provided in all cases.

2° The fireboxes in use at the present time are either deep, half-deep (overhanging the frame or otherwise) or flat.

From the constructional point of view the following types are met with : Belpaire fireboxes, round topped fireboxes, and fireboxes with roof bars (the latter only in exceptional cases).

We prefer the Belpaire firebox. In the more powerful locomotives which have large fireboxes, however, the Belpaire shape may be impracticable, in which case it is necessary to adopt the round topped firebox.

Fireboxes are made of copper.

Question d.

I. — Various smoke consuming devices have been used, and in particular the Marcotty and the Langer. Every type has finally been abandoned; where any are still in existence they are removed whenever a locomotive is repaired.

II. — The combined action of a swing door and the blower is considered a sufficiently effective system of smoke combustion.

It has never been possible to determine exactly what economy might result from the adoption of special smoke consuming devices.

III. — Spark arresters consist of cone-shaped netting in two pieces, fixed between the blast pipe and the chimney.

BELGIAN NATIONAL SOCIETY OF LIGHT RAILWAYS.

Question b.

II. — 1° Toothed grates made of cast iron are suitable for the burning of small coal. Wrought steel grates are more suitable for use with other kinds of coal.

2° The Belpaire type of fire box has always given satisfaction.

Question d.

III. — To avoid the throwing out of sparks, two perforated half-sheets are fixed in the smoke box, and as an additional precaution a spark collecting cover is placed on the top of the chimney.

The use of these two devices, which can be readily cleaned, appears entirely satisfactory.

FRENCH STATE RAILWAYS.

I. — The locomotives of the State Railways present no particular features as regards their fire boxes and grates. The fire boxes are either round topped or of the Belpaire type.

The oldest locomotives still in service have deep fire boxes with a small grate area (12.92 to 21.52 square feet). In recent locomotives with deep fire boxes, the grate area has increased to from 24.76 to 33.37 square feet. The most modern locomotives, with fire boxes overhanging the frames, have a grate area of about 43.05 square feet.

Fire boxes are made of copper, except in the case of certain locomotives of the « Consolidation » type built during the war.

II. — 1° As a rule it is desirable that there should be a dump grate; in the case of large fire boxes rocking grates contribute towards maintaining a suitable rate of evaporation through the journey.

2° The respective advantages and disadvantages of round topped fire boxes and Belpaire fire boxes are not easy to define, and we have no special observations to offer on this point.

It is however, recognised that copper fire boxes are more satisfactory than those made of steel; they are, in particular, less susceptible to sudden changes in temperature.

III. — The State Railways have experimented with the use of mazout for heating locomotive boilers. It has been found that mazout gives a 50 % saving in the weight of fuel to be carried, as compared with coal, for an equal amount of work done. In view of the fact that the price of a ton of mazout on the tender is appreciably higher than the price of 2 tons of coal, the trials were abandoned two years ago and have not since been resumed.

Question d.

I. — Locomotives are not fitted with smoke consuming devices; the smoke produced is reduced as far as possible either by means of the blast, or by the partial opening of the firedoor.

III. — In conformity with French Government regulations, the smoke boxes of locomotives are fitted with a spark arrester, consisting either of a grid composed of bars perpendicular to the axis of the boiler and fixed 10 mm. (3/8 inch) apart, or of metallic netting of 10 mm. mesh.

As such an arrangement does not completely prevent the discharge of sparks and the consequent risk of setting fire to adjoining property, the administration is experimenting on certain locomotives with an extinguisher device (Dallemagne system) in the hope of finding a suitable remedy.

This device consists of a basket-netting funnel of conical form, inside which is a coil and a diffuser; the sparks carried off in the burnt gases assume a spiral movement, and by centrifugal force are split up against the sides of the funnel, either falling back into the smoke box or escaping from the chimney, but in the latter case they are now so small and cooled that there is no risk of their causing a fire.

This device is successful in suppressing sparks but it has not been in use sufficiently long for an opinion to be formed as to whether it interferes with evaporation or increases the consumption of fuel.

RAILWAYS OF ALSACE-LORRAINE.

Question d.

I. — The smoke consuming devices previously in use have been dismantled because of the great expense entailed in keeping them in order.

II. — More or less the same result is obtained by merely opening the firedoor a little.

III. — On these railways two kinds of spark arresters are in use : locomotives of the older types are fitted with the grid form; those of more recent construction are fitted with the Holzapfel type of conical spark arrester.

These grids form a conical surface between the blast pipe and the base of the chimney. The mesh is 11 mm. (7/16 inch), and the wire is 3 mm. (1/8 inch) thick. This type of spark arrester has proved the most satisfactory.

When this apparatus is in good order it gives excellent results, and is sufficiently satisfactory to remove the risk of fire. On the other hand, the surface available for the escape of gases in the case of the flat grid type of spark arrester is greater than in the case of the conical type. The latter, however, do not wear out so quickly.

EASTERN RAILWAY COMPANY (FRANCE).

Question b.

I. — The use of the rocking grate makes it possible to run for longer periods without stopping to clean the firebars. The cost of maintenance is, however, higher than in the case of the fixed grate.

II. — The Eastern Company prefers the Belpaire type of fire box.

Question d.

III. — The only spark arresting device used on locomotives on the Eastern Railway Company's lines is a piece of metal netting fixed in the smoke box. (It is fixed above the tube openings, and the strands of the netting are 10 mm. [3/8 inch] apart).

MIDI RAILWAYS.

III. — With a view to preventing the discharge of sparks from the chimney, the smoke box on our locomotives has a horizontal grid composed of 4 mm. (5/32 inch) cylindrical bars placed 6 mm. (1/4 inch) apart, and fixed at the height of the exhaust.

In locomotives working in the wooded region of the Landes, this bar grid is supplemented by metallic netting composed of wire 2 mm. (5/64 inch) thick, with 4 mm. (5/32 inch) openings.

In addition to this there is a tap for spraying the smoke box.

PARIS-ORLEANS RAILWAY COMPANY.

Question b.

II. — *Grates.* — Where rocking grates are used, the ash and clinkers can be cleared away while running, and this improves the evaporation when the fire is becoming clogged. With these grates, therefore, it is possible to burn coal of inferior quality, and to increase the length of journeys without cleaning out and re-starting the fire. On the other hand, with these grates it is more difficult to obtain a regular spacing between the bars than in the case of the ordinary grate, and there is therefore a greater fall of cinders into the ashpans.

On the whole, it would appear desirable to have rocking grates on goods locomotives, where the length of the journey is considerable and fuel of lower quality is used; and also in the case of express trains which do very long journeys without change of engines (Tours to Bordeaux; Paris to Angers, *i. e.* more than 250 [155 miles]). Their use is less desirable when fuel of good quality is used, or when the journeys between changes of engine are short.

Fire boxes. — The Belpaire type of fire box, fixed between the frames, with cambered flat crownsheet, of the series 3591 to 3640 and 5811 to 5960, gives complete satisfaction from the point of view of evaporation, upkeep and durability.

Fire boxes with round crownsheets, of the series 1771 to 1800, and the American type « B » are more delicate, and the cost of upkeep is higher; they give, however, a satisfactory evaporation.

III. — 1° The various types of apparatus in use on our railway for the combustion of liquid fuel were described in detail in the January 1921 number of the *Revue générale des Chemins de fer et des Tramways.*

Since the above description was published, a third engine, of the « Pacific » type (1.950 m. [6 ft. 4 13/16 in.] wheels, superheater) has also been fitted with identical apparatus, except for the burner, which is of a special type comprising a steam turbine which by the rotation of one of its parts gives a more intimate mixture of the fuel oil and air, and imparts a conical shape to the flame.

3° The first trials were carried out between Paris and Tours in June 1920 with fluid mazout, and gave the following results :

Train No.	Date.	ROUTE.	Weight of train.	Average speed (kilometres per hour).	Time gained.	Total consumption.		Water vaporised per kilogram of fuel oil.	Consumption of fuel oil per 100 t.-km. (engine and tender included)
						Water.	Fuel oil.		
			Tons.	Kilometres.	Minutes.	Kilograms.	Kilograms.	Kilograms.	Kilograms.
1	8.6.20	Paris to St. Pierre-des-Corps	613	66.700	...	43.274	3.720	11.63	2.12
122	9.6.20	Tours to Paris	624	63.800	15	48.209	3.420	14.08	1.89
3	10.6.20	Paris to St. Pierre-des-Corps	528	71.700	22	39.336	2.980	13.20	1.91
122	11.6.20	Tours to Paris. . . .	540	64.940	24	43.071	2.980	14.45	1.85

Other trials were carried out during 1921 to compare the results obtained with fluid mazout and viscous mazout. There was very little difference between the respective results.

Comparison of the average consumption of mazout and coal, *under ordinary service conditions*, with locomotives of the same series executing the same work, shows that 1 kgr. (2.2 lb.) of mazout, average calorific power 10 500 (18 900 British thermal units per lb.), is equivalent to 1.7 kgr. (3.7 lb.) of coal, average calorific power 7 350 (13 230 British thermal units per lb.).

4° The apparatus used on our locomotives has up to the present given complete satisfaction both as regards the results obtained and the cost of upkeep of the apparatus itself and of the locomotive on which it is fitted. The use of this apparatus has made it possible to enumerate the following advantages of the use of mazout as compared with coal :

Greater speed in getting up steam.

Increased power of locomotives in view of the possibility of greatly increasing the production of steam by a given boiler.

Facility of handling, reduction of bulk and weight of fuel carried, suppression of residue such as clinkers, ash and cinders from the smokebox.

Very great reduction of the work of the fireman, with the consequent possibility of running much more powerful locomotives than those now in use without increasing present personnel.

On the other hand, it has not been found that the use of fuel oil causes a more rapid deterioration of the firebox than the use of coal, provided the necessary precautions are taken to avoid sudden lowering and raising of temperature.

We have not noticed any appreciable differences between the various kinds of liquid fuel used, so far as concerns facility of use and results obtained, in spite of the fact that they have had very varying characteristics, especially as regards fluidity.

We are unable to make an exact comparison between the net costs of the various kinds of liquid and solid fuel, as we have not used liquid fuel on a sufficiently large number of locomotives, or for a sufficient length of time, to be in a position to compile the requisite statistics.

On the basis only of the consumption of fuel, it may be taken that the economic equation between the two systems of heating is given by the ratio between the respective prices for an equal weight of both kinds of fuel :

$$\frac{\text{Mazout}}{\text{Coal}} = \text{(about) } 1.7.$$

The additional advantages of the use of fuel oil (particularly economy of labour at the depots) cannot be taken into account, because they would scarcely represent a sufficient saving to counterbalance the redemption of the appreciable amount of capital expenditure involved in equipping a large number of engines and providing the corresponding fixed installations.

Further, even taking into account the fact that the weight of mazout carried would be less than the equivalent quantity of coal, the transport of the oil would be at least as expensive as that of coal, for it must be remembered on the one hand that the tare of tank wagons, in proportion to the weight which can be carried, is higher than that of coal wagons, and on the other hand that tank wagons must necessarily run light on the return journey.

The prices of mazout and of coal in France necessarily vary according to the time, the place where used, and the source from which derived; and in the case of our railways the average price of mazout is at present higher than that of coal (on the basis of the above formula of equivalence), so that at the moment there is no advantage to be gained by extending the use of liquid fuel in our locomotives.

Question d.

All our locomotives are fitted with chimney or smoke box netting. This system is fairly effective in reducing the discharge of glowing particles, and no other type of spark arrester has been tried.

PARIS-LYONS-MEDITERRANEAN COMPANY.

Question b.

II. — a) *Type of grate adopted.* — The type of grate adopted on our railways consists of plain firebars, made of highly fire-resisting iron or steel, 10 mm. (3/8 inch) thick, and rivetted, the heads of the rivets (which are intended to maintain the correct spacing of the bars) being 10 mm. high. The total air-space between the bars is therefore equal to the covered grate area. The bars are rivetted at the side in pairs, and are specially shaped so that they may fit exactly on the sides of the firebox.

Our fireboxes have a *dump-grate* consisting of longitudinal bars rivetted on to two movable bearers. These bearers are in turn connected with a pivot, fixed to the firebox ring, and work on this pivot.

This system gives a satisfactory admission of air, and is well suited for the burning of small coal, which forms a very large proportion of the fuel used by us.

b) *Types of fireboxes adopted.* — « Crampton » fireboxes are still in use on our older engines, but not on the more recent ones.

Our modern engines have either a Belpaire firebox fixed between the frames, or a Wooten frame-overhanging firebox.

The fireboxes of those of our engines which were built in France are made of copper.

The Belpaire fireboxes used on a very large number of locomotives have proved most satisfactory. The simple nature of the staying and the stability of the vertical and transverse stays are among the main reasons which led to the adoption of this type, the only disadvantage which might perhaps be referred to being the difficulty of fixing the firebox to the boiler barrel.

The overhanging fireboxes of our « Pacific » and « Mikado » locomotives are also satisfactory. Their adoption, prompted by the necessity of increasing the grate area without unduly increasing the work of the fireman, has made it possible to simplify the connection between the firebox and the boiler barrel.

As regards the kind of metal used, we prefer *fireboxes made of copper,* because of the difficulty experienced in preventing leakage in steel fireboxes and the amount of attention which they require.

We have 745 locomotives of American or German origin with steel fireboxes.

III. — We have been compelled for various reasons, at certain periods, to use coal tar and mazout as liquid fuel.

Use of coal tar.

a) *History.* — In 1900, in order to keep the atmosphere of certain tunnels clear, we equipped a certain number of locomotives of the series 4001-4159 (8-coupled with 1.260 m. [4 ft. 1 5/8 in.] wheels) for mixed combustion, including the use of coal tar.

The coal tar was only burned while passing through tunnels; this made it possible to pass through the tunnel without firing or interfering with the fire, thus diminishing very considerably the proportion of obnoxious gases in the products of combustion.

The difficulty experienced in 1916 in obtaining supplies of coal tar, the artificial ventilation of tunnels, and the commissioning of more powerful locomotives led us to dismantle the apparatus installed for mixed combustion.

b) *Description.* — The tar was heated beforehand, then sprayed by means of steam from the boiler.

The burners used were of the *Holden* type.

c) *Results.* — The use of tar for heating was introduced, as stated above, in special circumstances for use during short periods and very irregularly. We have consequently not made a comparison between the costs of this system of heating and the cost of heating by coal.

Use of mazout.

a) *History.* — The world coal crisis which characterised the year 1919, and from which France suffered particularly, led us to contemplate the use of mazout for the heating of locomotive boilers.

First of all, towards the end of 1919, we began the adaptation for the *exclusive burning of mazout* of a series of 35 shunting engines (20 tank engines, 6-coupled with 1.300 m. [4 ft. 3 3/16 in.] wheels; 15 tank engines of German origin, 10-coupled with 1.340 m. [4 ft. 4 3/4 in.] wheels).

We first devoted our attention to shunting engines because this branch of the service was one which gave rise to many complaints. The poor quality of the coal very often supplied to us, in fact, compelled the drivers to stop in order to re-start the fire, or to run badly because the fire was not clean, thus hindering operations in the shunting yards.

Pursuing our programme, during 1920, with a view to experimenting with main line locomotives, we adapted :

— *for the exclusive burning of mazout :* 1 locomotive of series 4701-4982 (leading bogie, 8-coupled, 1.500 m. [4 ft. 11 in.] wheels);

— *for mixed combustion :* 1 locomotive of series 4001-4159 (8-coupled, with 1.260 m. [4 ft. 1 5/8 in.] wheels).

The results obtained with shunting engines having shewn, as will be seen later, that the use of mazout is distinctly more expensive than the use of coal, in February 1921 we dismantled the locomotives which had been adapted for the burning of liquid fuel.

What we say below only refers to shunting engines, the two main line locomotives having remained too short a a time in service in their modified form to enable us to draw any conclusions therefrom.

b) *Description.* — The *burners* used were of the *P. L. M. type.*

We have also tried *Omega burners*, which have given satisfaction.

Results. — The first trials have shown that 1 ton of mazout was equal to 1.65 tons of coal; but in practice this coefficient fell, in the case of certain qualities of mazout, to a lower figure, In December 1920 it was not more than 1.13, while the price of mazout was 600 francs per ton, and the price of coal had fallen to 190 francs per ton.

It may be interesting to record that the cost per kilometre during the month of December 1920 was :

Locomotives burning coal . . .	3 fr. 002
Locomotives burning mazout .	9 fr. 152

The above figures do not take into account the cost of fuel supply and the special attention necessary in the case of engines running on mazout.

It was therefore thought advisable to discontinue the use of mazout, and this we did at the beginning of 1921.

Question d.

I. *Firedoors with air-inlet. Swinging doors.* — Locomotives constructed to our specification are not fitted with smoke-consuming devices, but they have firedoors with air-inlets. The inlet, which is adjustable, is used to prevent the production of smoke when passing through stations or when the locomotive is stopped.

The firedoors on modern locomotives can, moreover, be partially opened by means of either a counterweight (as in the « Pacific » and « Mikado » engines) or a special lever.

II. *Marcotty smoke-consuming device.* — The German locomotives which were handed over to us after the Armistice are fitted with the Marcotty smoke-consuming device.

III. *Huwyler smoke consuming device.* — We are about to experiment with the Huwyler system on five of our locomotives.

If the fire has not been built up too thick, the driver of any of our locomotives can prevent the production of smoke by slightly opening the *blower*, and by permitting the direct admission of air above the fire, either by slightly opening the *firedoor* or by opening the *inlet* provided for the purpose in the door.

It is unquestionable, however, that a satisfactory form of smoke-consuming apparatus must improve combustion, especially when running with the regulator closed.

The *Marcotty apparatus* not being in proper working condition at the time of delivery to us of the German locomotives, we decided, in view of its complicated nature and small utility, not to refit the connections coordinating the working of the regulator, the blower and the swinging firedoor.

Further, the cataract device for the admission of air is an unwieldy and complicated piece of mechanism which requires considerable attention; we are replacing it, whenever engines are under repair, by the sliding door type, which is much more satisfactory.

Finally, we shall eventually be in a position to compare the advantages, from the point of view of consumption of smoke :

of the addition of a spray of steam at the brick arch;

on the one hand with automatic regulation of the secondary admission of air (Marcotty smoke-consuming system);

on the other hand, without automatic regulation of air (Huwyler system).

III. — We use the *chimney netting* type of spark arrester.

Our more recent locomotives have conical shaped grids, supported partly by the continuation of the chimney and partly by the blast pipe. These grids, which have a 10 mm. (3/8 inch) mesh, consist of metal trelliswork or netting.

CHALOSSE AND BEARN STEAM TRAMWAYS.

Question d.

III. — Our locomotives, which operate in wooded country, have a double spark arrester, which has proved satisfactory.

LANDES LOCAL RAILWAYS.

Question d.

III. — The locomotives of these railways operate in wooded country, and have a double spark arrester of the same type as used by the Midi Company. It may be stated that since the opening of the railways there has been no case of fire caused by spards. The staff scrupulously observe the regulations in this connection.

ALGERIAN STATE RAILWAYS.

Question b.

II. — 1° Old type 0-3-0, series 1 to 135.

Standard gauge : grate consists of bars in groups of four, the front part forming a dump grate;

2° Recent type 2-3-0, series 221 to 227, and new type 1-5-0, series 521 to 550 : rocking grates with movable dump grate at front.

Question d.

III. — *a*) Locomotives of old type 0-3-0, series 1 to 135, locomotives of recent type 2-3-0, series 211 to 267.

Two superimposed horizontal grids in the smokebox with baffle plates placed at the level of the blast pipe top. As this arrangement is not sufficient in itself, metal netting of 8 mm. (5/16 inch) mesh is placed on the lower grid.

b) Locomotives of new type 1-5-0, series 521 to 550 : a grid of metal netting in the smokebox at the level of the blast pipe top, and a cone-shaped spark arrester (8 mm. mesh [5/16 inch]) in the chimney.

3° and 4° The grids referred to in *a*) are not effective unless metallic netting is added to the first grid, as is done on our locomotives.

The grids referred to in *b*) are the most satisfactory.

TUNISIAN RAILWAY COMPANY.

Question b.

II. — 1° In general, our grates consist of wrought iron bars, 1 m. (3 ft. 3 3/8 in.) long, 100 mm. (3 15/16 in.) deep and 5 mm. (3/16 in.) thick; these bars are rivetted in groups of four, and are fixed 15 mm. (5/8 inch) apart for burning briquettes, or 12 mm. (1/2 inch) apart for burning coal. This type of grate is satisfactory.

Certain locomotives are fitted with rocking grates; this grate is much more satisfactory than the fixed type in the case of long journeys, as it does away with the necessity of stopping to clean the fire; the latter always remains clean, and evaporation is greater.

2° The Belpaire type of firebox is the one which in our opinion is the most satisfactory; repairs are easier; cleaning is more convenient; the volume of steam above the firebox crown is greater than in the case of other fireboxes.

On certain of our narrow-gauge locomotives the fireboxes are narrower at the bottom than at the top to permit of their being fixed between the frames; considerable repairs are necessary, as damage frequently occurs to the ogee portion which connects the two sections of the firebox; it appears very desirable to use fireboxes overhanging the frames in order to prevent this difficulty.

III. — 1° The mazout used by this company for the heating of certain tank-engines (series 681) is stored in a bunker fixed on the right-hand side of the engine behind the water-tank; in this bunker there is a coil through which steam circulates with the object of liquifying the mazout; the latter passes thence through tubing into a Baldwin steam ejector fixed on the back of the firebox; here the mazout is sprayed and projected on to the firegrate by means of a steam jet.

3° This company has only used mazout for a short time; we have not experimented with different types of apparatus.

4° The Baldwin ejector burner, used in connection with the combustion of mazout, has proved fairly satisfactory; the burner is regulated so as to prevent the discharge of black smoke from the chimney; this regulation is difficult to effect at night; in this case all that can be done is to look through the opening in the firedoor to see whether the fire is bright and whether the injection of mazout is satisfactory.

The burner deteriorates somewhat rapidly; further, the mouth becomes clogged, and the driver is often obliged to clean it out by means of a curved tube-cleaner which must always be carried on the engine.

5° Up to the present we have used only Mexican mazout from Tampico, and this has given satisfaction.

We have carried out consumption tests, using : 1° briquettes only; 2° a mixture of briquettes (84.75 %) and mazout (15.25 %). From the point of view of the quantities consumed, we have found that the consumption per ton-kilometre is 0.03615 kgr. (0.010028 lb. per English ton-mile) in the first case and 0.03025 kgr. in the second; i. e. a saving of 0.0059 kgr. (0.00163 lb. per English ton-mile) is effected by using briquettes and mazout together. (For the purpose of calculating the consumption in the second case, the weight of mazout consumed was converted into an equivalent weight of briquettes taking into account the respective calorific values and net costs.)

It is therefore advantageous to use mazout and briquettes; evaporation is greater and running easier; less exertion is demanded from the fireman.

In calculating the net cost, we do not take into account such factors as the capital locked up, provision for sinking fund, repairs, upkeep, etc.

Question d.

I. — 1° The consumption of smoke is effected in most of our locomotives by means of the ring blower, of openings in the firedoor; and of the deflection of the flames by the brick arch.

4° The action of the blower and brick arch combined is satisfactory, but the air openings in the firedoor sometimes effect the evaporation, especially on difficult routes, as the entrance of the cold air reduces the temperature of the firebox.

II. — The action of the blower with the partial opening of the air opening in the firedoor gives a satisfactory consumption of smoke, but results in a considerable expenditure of steam.

The brick arch is economical, but the smoke consumption obtained by this means alone is insufficient.

The use of the air openings in the firedoor gives a fairly satisfactory consumption of smoke; the resulting economy is not very considerable. The openings are used, on locomotives which burn mazout, for observing the condition of the fire and the combustion of the liquid fuel.

III. — 1° The spark arresters in use consist of grids of metal netting of 8 mm. (5/16 inch) mesh, fixed in the smokebox and ashpan dampers. The sparks are further checked by means of a deflector plate, fixed in front of the tubes; finally, on certain locomotives which have a powerful blast, a vertical conical spark arrester is fitted in the chimney above the blast pipe.

3° We have used this system for a very long time; other systems have not been tried.

4° This apparatus, if well looked after during the hot season, has been found satisfactory, as it greatly reduces the amount of glowing cinders and sparks which fall on to the line.

GENERAL ADMINISTRATION OF RAILWAYS AND PUBLIC WORKS.

DAMASCUS-HAMAH RAILWAYS AND EXTENSIONS.

Question b.

II. — *Consumption :* If the space between the firebars is reduced to 9 or 10 mm. (3/8 or 25/64 inch), the combustion of the coal is less satisfactory; evaporation is reduced to the extent of 1/2 kgr. (1.1 lb.) of water per kilogramme of coal.

With firebars 15 mm. (5/8 inch) apart, combustion is good, but the evaporation is less, for much more combustible matter falls into the ashpan, particularly in the case of unscreened coal. The grates in use on these railways give satisfaction.

Nature and upkeep of grates. — The cast iron firebars (manufactured locally) cost as much as wrought iron bars and wear out much more rapidly.

Wrought iron bars can generally be repaired.

Question d.

III. — 1° On locomotives of ordinary narrow gauge lines and locomotives of standard gauge lines, there is in the smokebox an iron grid composed of bars placed 1 cm. (25/64 inch) apart, fixed at the height of the exhaust and of the upper row of tubes.

On locomotives of our narrow gauge rack railways the blast pipe is surrounded by strong metal netting of 1 cm. (25/64 inch) mesh.

This conical netting begins at the top of the blast pipe, over which it fits closely, and ends at the chimney base, inside which it fits tightly.

2° The ashpans also are fitted with grids of metallic netting in the case of standard gauge engines.

3° The two types of spark arresters give satisfaction.

4° The spark arresters made of coarse netting are easier and cheaper to construct; they can also be taken down rapidly and re-fitted when it is necessary to clean the tubes.

GENERAL ADMINISTRATION OF RAILWAYS AND PUBLIC WORKS.

SMYRNA-CASSABA RAILWAYS AND EXTENSIONS.

Question b.

III. — In the grates of locomotives C 8-G 10-40 the bars are too close together, the spaces being 9, 10 and 12 mm. (3/8, 25/64 and 15/32 inch). The spacing should be increased to from 20 to 22 mm. (from 13/16 to 7/8 inch).

Question d.

III. — All locomotives are fitted with grid spark arresters fixed in the smokebox, either flat and horizontal, or consisting of two half cones which fit together at the base and are placed around the blast pipe.

They are made of metal netting in which the wires are from 1.5 to 2.0 mm. (from 1/16 to 5/64 inch) in diameter and are placed 10 mm. (25/64 inch) apart.

These spark arresters have proved satisfactory.

KAYES-NIGER RAILWAY.

Question d.

III. — Spark arresters, « Sudan » type. The apparatus consists of a 3 mm. (1/8 inch) steel sheet composed of an inverted cone in two sections, a deflector and a covering of metallic netting made of 3 mm. (1/8 inch) wires placed 4 mm. (5/32 inch) apart.

This type has proved satisfactory.

KONAKRY-NIGER RAILWAY.

Question b.

II. — The firegrates and fireboxes in use have been found satisfactory.

Question d.

III. — The spark arresters fitted on locomotives consist of a steel sheet between the blast pipe and the chimney; this which is cylindrical in its lower part, is surmounted by two sections of a cone of different heights, connected at the base, which is their widest part.

At the connection of these two conical sections, as well as at the upper part of the spark arrester, there is a piece of metal netting with square openings of 5 mm. (3/16 inch) side; the dimensions of each of these two sheets of netting are calculated so as not to interfere with the draught.

The sparks, which are stopped by these two nettings fall back in the form of ash and collect round the blast pipe, from which they are removed when necessary through an opening specially provided for the purpose.

ITALIAN STATE RAILWAYS.

Question b.

I. — The firebox is generally made of copper. Steel fireboxes are only used on our lines in certain locomotives of German origin or of American construction.

These are being renewed by copper ones as the locomotives come in for repairs.

The grate areas of our modern locomotives are from 2.5 m² to 3.5 m² (26.91 to 37.67 square feet). Grates with an area of 4.3 m² (46.28 square feet) are only found in recent types of locomotives for mountain lines (10-coupled with leading wheel, 1E) and in fast train locomotives (8-coupled with leading and trailing wheels, 1D1).

We have adopted a standard type of grate with three different lengths of firebars : 300 mm., 360 mm., and 380 mm. (11 13/16 inches, 1 ft. 2 3/16 in. and 1 ft. 2 15/16 in.).

With these three dimensions we are able to obtain satisfactory results on all our locomotives.

III. — At the present time we have no locomotives which burn liquid fuel. We have, however, carried out certain very important experiments with different types of liquid fuel burners (compressed air, gravity feed, steam, mixed combustion); but the cost of liquid fuel in Italy prohibits its use on our locomotives.

IV. — We have recently carried out trials with a « Consolidation » locomotive fitted with new apparatus for the burning of pulverised fuel.

The Fuller system, which has been adopted on two locomotives built in America for burning powdered lignite, has not given satisfactory results. These locomotives have never handled a regular train service.

Question d.

We do not attach great importance to the form of the spark arrester. Tests are being carried out, however, with different types with a view to arriving at the most perfect form possible.

PRINCE-HENRI RAILWAYS AND MINES.

Question b.

The P. H. type having been found the most satisfactory, it has been adopted on all our locomotives.

Question d.

Of the types of spark arrester used on locomotives belonging to this company, the funnel shape has been found the most effective.

NORWEGIAN STATE RAILWAYS.

Question b.

I and II. — On the Norwegian State Railways only one kind of firebox and only one kind of grate is used, adapted as required to the different types of locomotives.

The firebox is generally made of copper; steel fireboxes are an exception.

Question d.

I and II. — In order to secure a certain degree of smoke consumption, use is made of a device allowing for regulation of the air supply above the grate.

III. — The spark arrester in use consists either of a perforated iron sheet or of metal netting placed in the smokebox against the chimney. This spark arrester is generally either cylindrical or conical.

DUTCH RAILWAYS.

Question b.

IV. — Two fast locomotives have been adapted, on the Fuller system, for the burning of powdered coal. It is not yet possible to give the results of the tests.

Question d.

III. — 1° The spark arrester used consists of an iron sheet perforated with holes 10 mm. (25/64 inch) in diameter, or of a grid formed of round iron bars fixed 10 mm. apart.

3° The spark arresters have proved satisfactory.

4° The spark arresters in the form of a perforated iron sheet have an advantage over the grid type in that the openings cannot become enlarged.

DUTCH EAST INDIAN RAILWAY COMPANY.

Question b.

II. — The use of wood as fuel renders it necessary to have firegrates with wide spaces between the bars; and fireboxes large enough to hold a very deep fire. The use of an arch is impossible, as it would be damaged by the pieces of wood which are thrown into the fire.

Question d.

III. — The spark arresters used consist of a metal grid with six holes to the inch. The two systems adopted are :

1° The grid is fixed on a detachable iron frame;

2° The grid takes the form of a cover on the chimney.

The second system has the advantage that the grid does not become blocked.

DUTCH EAST INDIAN RAILWAYS (JAVA).

Question b.

II.— The larger locomotives have ordinary firegrates with a rocking part in front. This system has proved satisfactory.

For the very largest locomotives (of the type 1 D+D) rocking grates have been found the most suitable. The ordinary types of firebox are quite satisfactory.

Question c.

We do not use mechanical firing devices. The automatic of the American

Locomotive Company worked satisfactorily, but it increased the permissible weight, and its use had therefore to be abandoned.

Question d.

I. — 1° and 2° We have adopted the Marcotty smoke-consuming system (with swing door) and the Langer system.

The chimney covers used are of simple construction, and are quite effective.

SWEDISH STATE RAILWAYS.

Question b.

IV. — We have 18 locomotives adapted for burning of powdered peat. The peat is extracted from a peat bog belonging to the State and situated near the station of Vislanda in the south of Sweden. The powdering is done in a factory by the side of the peat bog, and the powdered peat is conveyed in tank-wagons to the Nässjö-Falköping line, on which the majority of the locomotives burn this form of fuel. The distance between Nässjö and Vislanda is 101 km. (62.7 miles), and the length of the Nässjö-Falköping line is 112 km. (69.6 miles).

The use of powdered peat for firing locomotive boilers was begun during the war when the price of coal was very high. Now that the price of coal has decreased considerably, we have found that it is not economical to burn powdered peat in view of the extremely high cost of production.

We have also experimented with the use of powdered coal on three locomotives. In view of the very unfavourable economic results obtained this form of fuel has already been abandoned, and the apparatus specially provided for its use has been dismantled. Among other disadvantages discovered when using this kind of fuel we may refer to the increased internal resistance of the locomotive ; the steam consumption was appreciably increased, probably due to the sucking up of the powder into the steam chests and it increased the friction on the slide valves and pistons.

SWISS FEDERAL RAILWAYS.

Question b.

III. — **Experiments with liquid fuel for heating locomotive boilers.**

(May-July 1921.)

A. — EQUIPMENT.

I. — *Mixed combustion, locomotive 3/5 N. D., No. 709.*

Holden-Hardy (Vienna) type of burner, fitted to the back wall of the firebox, about 300 mm. (11 13/16 inches) above the grate. The normal form of arch is extended a distance equivalent to the width of another row of bricks. Fire-proof bricks covered the tube plate between the arch and the grate. No other modification in the firebox.

On the tender, above the back part of the water tank, there is a rectangular oil tank holding about 3.5 tons and containing a heating coil. The oil is drawn off from the tank through a tap fitted with a filter to catch dirt. The oil passes through the regulating tap and from thence to the two burners, through the pre-heater which is placed at the left in the cab. The spraying is done by steam. The burner has two tubes, an external annular tube for the steam and the internal one for the fuel oil. Impurities and dirt which collect in the oil tubing can be cleared away by means of an arrangement for forcing steam through the tubes.

II. — *Burning of oil alone, locomotive 3/5 N. D., No. 731.*

Two burners of equal size, of the Holden-Hardy type. Fitted below the back side of the firebox, about 150 mm. (6 inches) below the firebox ring, and about 300 mm. (11 13/16 inches) on either side of the centre line of the boiler. The firegrate and ashpan are removed; the firebox is closed at the bottom by means of an iron frame with a coating of firebricks. A small lighting grate, size about 0.5 m² (5.3 square feet), is fitted in the front half of this frame. Air is admitted through suction valves fixed below this grate and in the sides of the frame; also through inlet grooves in the back half of the grate which can be closed by slides. The normal arch is extended towards the door plate to a distance equal to the width of four ordinary bricks. Below the arch the tube plate is lined with firebricks. There is an oil tank on the tender holding 5 tons, in the position ordinarily occupied by the coal bunker. The oil tank contains heating coils. The oil is brought to the burners in the same manner as described in the case of mixed combustion on locomotive No. 709.

B. — TRIALS.

I. — *Fuel oil used.*

In November 1920, fuel oil was obtainable at 292 francs per ton, delivered in tank wagons. If tank wagons were not provided by the railways, the price per ton, delivered at Geneva-Cornavin, was 348 francs.

In August 1921, fuel oil of the same quality was offered at 141 fr. 40 per ton, delivered at Geneva-Cornavin.

The fuel oil is a crude oil, highly sulphurous (up to 4 %), thick (pasty at 0° C. [32° F.]), 9 500 calories (17 100 British thermal units per lb.), specific gravity at 15° C. (59° F.) = 0.961. Viscosity at 50° C. (122° F.) = 45.1; at 100° C. (212° F.) = 4.8 Engler degrees. Flash point in open crucible, 126° C. (259° F.). Ignition point, 156° C. (313° F.).

Considerable pre-heating is necessary with this oil up to 90° C. [194° F.] at the burner).

II. — *Mixed combustion, locomotive 3/5 N. D., No. 709.*

Trial runs were made in the first place with goods trains, and then with fast trains on the Olten-Berne line. It is highly important that the burners should be fixed in a suitable position; if the flame is placed too low, this results in the rapid combustion of the layer of coal on certain parts of the grate, which makes it necessary to replenish the coal rapidly in order to avoid cold air rushing in. At times this has resulted in an excessive consumption of coal, even when using hard coal of inferior quality.

Better results have been obtained by covering the whole length of the grate with an even layer, 50 cm. (1 ft. 7 11/16 in.) wide and 10 cm. (3 15/16 inches) thick, of pieces of firebrick, and by only spreading the layer of fuel on the side portions of the grate. Air drawn in through the grate was thus heated to a certain extent when passing through the pieces of incandescent firebrick. Under this arrangement the supplementary use of fuel oil gives good results. On the other hand the change from mixed combustion to the exclusive burning of coal (in case of damage to the burner) is rendered very difficult because of the layer of pieces of firebrick placed on the grate. In the case of auxiliary heating with fuel oil, to which it may be necessary to resort momentarily on difficult parts of the line where a higher evaporation is essential, or in cases in which it is desirable momentarily to reduce the production of black smoke, it is preferable to resort to mixed combustion without having the layer of pieces of firebrick on the grate.

III. — *Use of oil only, locomotive 3/5 N. D., No. 731.*

Trial journeys with fast trains, for total runs of about 1 700 km. (1 056 miles) per train, on the lines Zurich-Berne, Basle-Berne, Basle-Lucerne, Basle-Delsberg-Biel.

Dynamometer car tests on the Zurich-Olten-Berne line with train 12, June 21/27, 1921.

	Zurich-Olten.	*Olten-Berne.*
Length of line	62.76 km. (38.99 miles).	66.89 km. (41.56 miles).
Weight of train	362 tons.	464 tons.
Timetable length of journey	66 minutes.	70 minutes.
Actual time taken	63 1/2 minutes.	68 minutes.
Average speed	59.3 km. (36.84 miles) per hour (3 starts).	59 km. (36.66 miles) per hour (1 start).

In 1915, for purposes of comparison, two trial journeys were made with locomotives of the same type, with fast trains having the same timing, and on the same line, but using coal. The comparison shows that with oil alone, the evaporative capacity of the boiler can be appreciably increased. On the Olten-Berne, section the maximum possible evaporative capacity was most probably attained. During this test it was only necessary to half open the tap which regulates the admission of the oil in order to avoid the production of black smoke. No exact details are available regarding the consumption of steam required for spraying the oil. If one compares the expenditure of steam per indicated H. P. for locomotive No. 711 with that for locomotive No. 731, it is found that for locomotive No. 731 there is an additional expenditure of about 12.5 % on the Olten-Berne line, attributable to the spraying of the oil. On the Zurich-Olten line the difference is considerably greater, since a large quantity of steam escaped through the safety valves. Sanzin estimates the amount of steam necessary for spraying at least 10 %; the amount depends, of course, on the nature of the spraying; in the Fowler report the figures vary between 2 and 7 %, but these are not always exact. In the course of subsequent tests an attempt was made to maintain the boiler pressure constant at 15 atmospheres (220.6 lb. per square inch). It was just possible to do this; but it was necessary to put up with an undesirable escape of steam from the safety valves on the Zurich-Olten line with a train weighing 362 tons, and with two stops, one at Baden and one at Aarau, of 1 1/2 and 5 minutes respectively. With a view to obtaining more satisfactory combustion in cases where the power to be developed varies considerably, as in the case of suburban trains with frequent stops, the most satisfactory arrangement appears to be to have two burners, one above the other (one large and one small), or three burners placed side by side (one small one between two large ones).

As regards the economic value of fuel oil, the price of solid fuel and of liquid fuel must show a given ratio, which in turn depends on the efficiency of the heating and consequently the boiler output. During the tests on locomotive No. 711 a boiler efficiency of 64.2 % was obtained, with a coefficient of evaporation of 7.18; and best Ruhr briquettes which gave a calorific value of 7 500 calories (13 500 British thermal units per lb.). Locomotive No. 731 reached a boiler efficiency of 78.4 %, with a coefficient of evaporation of 11.1, and a calorific value for the fuel oil of 9 500 calories (17 100 British thermal units per lb.). In both cases the maximum pressure of 15 kgr. per cm^2 (213 lb. per square inch) was maintained.

From the equation $\frac{9\,500 \times 78.4}{7\,500 \times 64.2} = 1.54$ it follows that 1.54 kgr. (3.39 lb.) of coal is equal to 1 kgr. (1.2 lb.), of fuel oil. On the basis of the present price of coal, 60 Swiss francs per ton, the price of oil ought not to exceed 1.54 × 60 = 92.40 Swiss francs.

Question b.

IV. — There are no locomotives on these railways adapted for the burning of pulverised fuel. Trials have, however, been carried out, and in the light of the experience gained by the Federal Railways, it would appear that it is not the actual equipment of the locomotives, but rather the preparation of the coal, which is the difficulty.

As the trials were carried out with a single locomotive, it was not worth while to provide a costly installation for the grinding, drying and powdering of fuel. The Federal Railways derived their supplies from existing cement works, the rotary furnaces of which are heated by means of pulverised fuel.

These works supplied the necessary coal, carrying it in wooden cases to the engine depot, a distance of about 20 km. (12.4 miles). The preparation of the coal was entirely satisfactory, but the *quality* of the fuel (which was quite suitable for the furnaces of the cement works) was not suitable for the locomotive tests. The percentage of volatile matter in the coal used should have been at least from 20 to 30 %, whereas the actual percentage was not more than from 12 to 14 %. Although the increase in the temperature of the firebricks of the firebox has a great influence on the inflammability of the pulverised fuel, it would appear necessary to use coal which is more or less bituminous. The Federal Railways being unable to use coal from their stock for this purpose, these tests were abandoned.

At the present day the constant progress made in the electrification of railways scarcely justifies the undertaking of so complete a transformation of the system of firing locomotives as was done in this case. It would indeed be difficult to arrive at any sufficiently satisfactory solution, in view of the changes which would be necessary in the engine depots.

If, however, this new method of heating locomotives has not proved a success in the case of the Federal Railways, it was not the system itself which was at fault, but rather the lack of the necessary accessories which made it impossible to obtain satisfactory results.

There is no question that, given a complete installation for the preparation of the fuel in a suitable manner, the system would be a success economically.

Further, it is beyond doubt that for the heating of fixed boilers, furnaces, etc., this method presents fewer difficulties. It is surprising to find that in the United States, where this new method of using pulverised fuel has just been introduced, locomotives of this class are still very few in number.

Question d.

I. — The majority of the main line locomotives have a smoke consuming device on the Langer or the C. F. F. system.

These two systems are effective, provided they are properly handled.

II. — It has not been found that any saving of fuel is effected by using smoke consuming devices.

III. — Almost all the locomotives of the Federal Railways are fitted with spark arresters, fixed in the smoke-box. These spark arresters are of a practical type, and have proved effective.

RAILWAYS
OF THE CZECHOSLOVAKIAN REPUBLIC.

Question d.

The use of lignite in small lumps, which is the general practice, causes a considerable discharge of sparks, thus increasing the danger of causing fires.

For this reason we have adopted — particuarly in the case of goods train engines — diamond smoke stacks with a movable cast-iron grid. At the same time we have improved the exhaust by changing the height of the blast pipe and by introducing a cross-bar in it. This arrangement of the chimney helps to reduce considerably the throwing out of sparks, while increasing the back pressure and reducing the vacuum in the smokebox. On the other hand, it results in an increase in the amount of fuel consumed. For this reason we use straight cylindrical chimneys, or if necessary slightly conical chimneys, without cover or grating; this also applies to goods train engines.

The spark arrester used by us consists of a sieve, either conical or in the form of the lower half of a pyramid, fitted in the smokebox; this sieve surrounds the blast pipe and the chimney petticoat. The sieve intercepts the sparks before they are put into motion by the action of the exhaust steam. It can be removed, either wholly or partly, to allow of lighting the fire.

TABLE III.

Replies to Lis

(QUESTION

DESIGNATION OF TYPES OF LOCOMOTIVES. (*Categories A, B, C, D.*)	Types of firebox (summary description and dimensions).	Grate area in square metres.
		Belgian Sta
B.	Various.	2.25 to 5.00
C.	Various.	1.26 to 3.13
D.	Belpaire, not deep.	1.45 to 5.05
		National Society
Type C.		
Type 1. — 12.5 t. light weight	Square firebox, Belpaire type.	0.642
— 2. — 14.5 t. —	Ditto.	0.645
— 3. — 15 t. —	Ditto.	0.725
— 4. — 16.5 t. —	Ditto.	0.725
— 5. — 16.5 t. —	Ditto.	0.756
— 6. — 18.8 t. —	Ditto.	0.785
— 7. — 24 t. —	Ditto.	0.950
— 8. — 14.5 t. —	Ditto.	0.640
— 9. — 24 t. —	Ditto.	1.280
— 10. — 23 t. —	Ditto.	1.170
— 11. — 23 t. —	Ditto.	1.170
— 12. — 23 t. —	Ditto.	1.170
— 13. — 22.7 t. —	Ditto.	1.080
— 14. — 26 t. —	Ditto.	1.070
— 15. — 16.5 t. —	Ditto.	1.020
— 16. — 18.8 t. —	Ditto.	0.720
— 18. — 18 t. —	Ditto.	0.750
		South Manchur
		Square feet.
« Inspection » 2-2-4	Wagon wide.	9.5
« Prairie » 4-6-2	Wagon narrow.	22.6
« Double-ender » 2-6-4	Ditto.	26.2
« Eight-wheeler » 0-8-0	Wagon wide.	40.0
« Consolidation » 2-8-0. H1	Wagon narrow	34.2
H2	Ditto.	46.6
H3.4	Wagon wide.	49.0
« Mikado » 2-8-2.	Ditto.	54.5
« Decapod » 2-10-0.	Ditto.	50.8
« American » 4-4-0.	Wagon narrow.	26.7
« Ten-wheeler » 4-6-0. F1	Ditto.	32.2
F2	Belpaire narrow.	31.5
« Pacific » . . . . G	Wagon wide.	50.2
G2	Ditto.	44.0
G1	Ditto.	50.2

of questions. **Table III.**
, *c* and *d*.)

ailways.

Metal used for firebox.	Type of grate (plan or sketch referred to).	*Remarks.*
Copper (1).	Grate with sets of bars, or rocking grate.	(1) All locomotives of German or American origin which had an iron or steel firebox are gradually being refitted with a copper firebox.
Ditto.	Ditto	
Ditto.	Grate with sets of bars.	

ight Railways (Brussels).

Metal used for firebox.	Type of grate (plan or sketch referred to).	*Remarks.*
Copper.	Steel grate.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Cast-iron grate, Libert type.	
Ditto.	Steel grate.	
Ditto.	Cast-iron grate, Libert type.	
Ditto.	Ditto.	
Ditto.	Steel grate.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto,	
Ditto.	Steel grate, Pelaert type.	

ailway Company.

Metal used for firebox.	Type of grate (plan or sketch referred to).	*Remarks.*
Steel.	Rocking grate.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	

TABLE III. (*Continued.*)

DESIGNATION OF TYPES OF LOCOMOTIVES, (*Categories A, B, C, D.*)			Types of firebox (summary description and dimensions).				Grate area in square metres.
							Danish Stat
Passenger train locomotives			...				1.30 to 3 23
Mixed train locomotives			...				0.90 to 1.20
Goods train locomotives			...				1.28 to 2.62
Shunting engines			...				0.68 to 1.11
							Railways of
				a (1)	*b*	*c*	
B.	S12	2C1	Belpaire.	2.986	1.790	1.167	3.220
	S14	2C1	Ditto.	2.460	1.845	1.650	4.270
	S10^{1}	2C	Crampton.	2.825	1.905	1.040	2.950
	S10	2C	Ditto.	2.825	1.905	1.040	2.820
	GS^{1}	D	Ditto.	2.445	1.802	1.180	2.630
	G8	D	Ditto.	2.445	1.802	1.180	2.390
	G10	E	Ditto.	2.583	1.800	1.170	2.600
	G12	1E	Ditto.	2.010	1.710	1.540	3.900
	G14	1D	Ditto.	2.853	1.709	1.730	3.030
C.	S5	2B	Belpaire.	2.210	1.600	1.040	2.280
	S9	2C	Ditto.	2.628	1.613	1.110	2.750
	P7	2C	Ditto.	2.729	1.634	1.160	2.750
	G11	1E	Ditto.	2.720	1.750	1.154	2.770
	T17	2C2	Ditto.	1.874	1.695	1.040	1.960
	S3	2B	Crampton.	2.200	1.320	1.040	2.270
	S7	2B1	Ditto.	1.348	1.660	1.493	2.710
	P2	1B	Ditto.	1.393	1.207	1.010	1.460
	P3	2B	Ditto.	1.991	1.313	1.015	2.060
	P4	2B	Ditto.	2.070	1.345	0.986	2.060
	P6	1C	Ditto.	2.420	1.762	1.017	2.250
	P8	2C	Ditto.	2.500	1.850	1.030	2.620
	G1	C.	Ditto.	1.390	1.250	1.020	1.650
	G2	C.	Ditto.	1.370	1.430	1.020	1.460
	G3	C.	Ditto.	1.430	1.520	1.020	1.530
	G4	C.	Ditto.	1.490	1.360	1.020	1.590
	G5	1C	Ditto.	2.225	1.500	1.105	2.300
	G7	D.	Ditto.	2.200	1.410	1.100	2.250
	T9	1C	Ditto.	1.450	1.600	0.980	1.530
	T11	1C	Ditto.	1.750	1.474	1.040	1.730
	T12	1C	Ditto.	1.600	1.680	1.030	1.700
	T13	D	Ditto.	1.700	1.485	1.020	1.700
	T14	1D1	Ditto.	2.491	1.681	1.123	2.500
	T16	E.	Ditto.	2.200	1.635	1.175	2.260
	T18	2C2.	Ditto.	2.316	1.685	1.100	2.420
	T31	C.	Ditto.	0.690	0.875	0.800	0 521
	T37	D.	Ditto.	0.900	1.010	0.950	0.938
D.	T3	C.	Crampton.	1.120	1.015	1.020	1.350
	T4	1B	Ditto.	1.460	1.100	1.020	1.520
	C5	1B2	Ditto.	1.810	1.387	1.070	1.960

TABLE III. (*Continued.*)

Metal used for firebox.	Type of grate (plan or sketch referred to).	*Remarks.*
Railways.		
Copper.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
lsace-Lorraine.		
Copper.	...	(1) $a =$ Average length of firebox. $b =$ Average height of firebox. $c =$ Average width of firebox.
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	

TABLE III. (*Continued.*)

DESIGNATION OF TYPES OF LOCOMOTIVES.	Types of fireboxes (Description and dimensions).						
	Types of fireboxes.	Height of crown above foundation ring		Inner width		Inner length	
		front.	back.	top.	bottom.	top.	bottom.
						Eastern Railway	
Class A ([1]) ([2]).		Metres.	Metres.	Metres.	Metres.	Metres.	Metres.
Series VI (tank-engines) 0-3-0	Crampton.	1.280	1.280	0.936	0.948	0.913	0.947
Series II 1-2-0	Ditto.	1.428	1.428	0.998	0.914	1 090	1.128
Series III. 1-2-1	Ditto.	1.492	1.222	1.028	0.918	1.552	1.605
Class B.							
Series XIII . . . . 1-3 + 3-0	American type	1.752	1.321	Sloping back plate	1.648	...	2.283
Series V 0-3-0	Crampton.	1.416	1.416	0.998	0.913	1.028	0.055
Series VI (tank-engines) 0-3-0	Ditto.	1.300	1.300	0.950	0.972	1.150	1.172
Series VII 0-3-0	Ditto.	1 492	1 492	1.022	0.918	1.200	1.207
Series VIII (tank-engines) 1-3-0	Ditto.	1.335	1.345	1.100	1 020	1.500	1 550
Series VI 0-3-0	Ditto.	1.592	1.592	1.022	0.918	1.188	1.215
Series VII 0-3-0	Ditto.	1.592	1.592	1.022	0.918	1.188	1.215
Series IX (« Mallet » locomotives) . . 0-2 + 2-0	Ditto.	1.770	1.520	1.200	1.000	1.856	1.942
Series XIII (tank-engines) 1-5-1	Belpaire.	2.240	1.510	1.370	0.990	2.635	3.055

TABLE III. (*Continued.*)

Grate area.	Metal used for firebox.	Type of grate horizontal (H) or inclined (I).	 fixed (F) or rocking grate (R).	 Position of drop grate.	*Remarks.*
mpany, France					
Square metres					
0.900	Copper.	H	Fixed grate.	...	(1) The grates of the locomotives of this railway consist of sets of cast iron bars of the types shewn in the attached plan (N° 39513), according to the dimensions of the firebox. The bars are 9 mm. thick and are placed 10 mm. apart. The drop grate consists of a set of transverse iron bars 20 mm. thick, with 10 mm. spacing. (2) The figures placed below the designation of the locomotive series indicate : independent leading bogies or axles ; the number of coupled axles ; independent trailing bogies or axles.
1.050	Ditto.	I (11°30′)	Ditto.	...	
1.500	Ditto.	I (12°)	Ditto.	...	
3.800	Ditto.	I	Ditto.	Two sections placed longitudinally, one on each side of the grate.	
0.960	Ditto.	H	Ditto.	...	
1.140	Ditto.	H	Ditto.	...	
1.110	Ditto.	H	Ditto.	...	
1.580	Ditto.	H	Ditto.	...	
1.120	Ditto.	H	Ditto.	...	
1.120	Ditto.	H	Ditto.	...	
1.960	Ditto.	I	Ditto.	...	
3.084	Ditto.	I	Ditto.	At 700 mm. from the tube plate.	

TABLE III. (*Continued.*)

DESIGNATION OF TYPES OF LOCOMOTIVES.	Types of fireboxes (Description and dimensions).						
	Types of fireboxes.	Height of crown above foundation ring		Inner width		Inner lengt	
		front.	back.	top.	bottom.	top.	bot
						Eastern Rail	
		Metres.	Metres.	Metres.	Metres.	Metres.	Me
Series XIII^{h} 1-5-0	Crampton.	2.185	1.800	1.570	1.0035	2.708	3.
Series XI 0-4-0	Ditto.	1.855	1.490	1.240	1.000	2.300	2.
Series VIII (tank engines) 1-3-1	Ditto.	1.628	1.358	1.067	0.990	1.755	1.
Series XII 0-4-0	Ditto.	2.000	1.620	1.320	1.010	2.256	2.
Series XI (tank engines) 1-4-1	Belpaire.	1.827	1.442	1.220	1 000	2 294	2.
Series III 0-2-1	Crampton.	1.575	1.380	1.040	1.004	1.552	1.
Series IV 0-2-1	Ditto.	1.495	...	1.023	0.992	1 650	1.
Series VIII^{c} 1-3-0	Belpaire.	1.860	1.430	1.184	0.998	1.917	2.
Series VIII^{c}. Suburban, with bogies (tank engines) 2-3-0	Crampton.	1.628	1.368	1.067	0.991	2.2055	2.
Series XI^{c} (tank engines) 2-3-2	Belpaire.	2.157	1.512	1.062	1.000	2.394	2.
Series VIII^{v} (locomotives with large driving wheels) 2-2-1	Ditto.	2.030	1.580	1.230	0.991	2.674	2.
Series XI^{c} 2-3-0	Ditto.	2.182	1.537	1.062	1.000	2.394	2.
Series VIII^{v} (locomotives with large driving wheels) 2-2-0	Ditto.	1.860	1.568	1.219	1.006	2.420	2.

TABLE III. (*Continued.*)

Grate area.	Metal used for firebox.	Type of grate			*Remarks.*
		horizontal (H) or inclined (I).	fixed (F) or rocking grate (R).	Position of drop grate.	

mpany, France. (*Continued.*)

quare metres.					
3.310	...	I	Fixed grate	In the middle.	
2.390	Copper.	I	Ditto.	Ditto.	
1.820	Ditto.	I (13°)	Ditto.	...	
2.620	Ditto.	I	Ditto.	In the middle.	
2.422	Ditto.	I	Ditto.	700 mm. from the tube plate.	
1.630	Ditto.	I (9°11′)	Ditto.	...	
1.710	Ditto.	I (11°12′)	Ditto.	...	
2.060	Ditto.	I	Ditto.	At front.	
2.260	Ditto.	I (13°)	Ditto.	...	
2.570	Ditto.	I	Ditto.	At front.	
2.740	Ditto.	I	Ditto.	Ditto.	
2.570	Ditto.	I	Ditto.	Ditto.	
2.520	Ditto.	I	Ditto.	Ditto.	

TABLE III. (*Continued.*)

DESIGNATION OF TYPES OF LOCOMOTIVES.	Types of fireboxes (Description and dimensions).						
	Types of fireboxes.	Height of crown above foundation ring		Inner width		Inner lengt	
		front.	back.	top.	bottom.	top.	bott
						Eastern Railway Compa	
		Metres.	Metres.	Metres.	Metres.	Metres.	Metr
Series VIII^v (locomotives with large driving wheels) 2-2-1	American.	1.760	1.560	1.300	1.686	1.344	1.5
Series IV 1-2-0	Crampton.	1.628	1.023	1.070	1.015	2.195	2.5
Series XI^c 2-3-0	Belpaire.	2.182	1.539	1.220	1.000	2.394	2 4
Class C.							
Series IX^c 0-4-0	Crampton.	1.590	1.240	1.285	1.000	2.200	2.2
Series IX^c (« Mallet » locomotives) 0-2 + 2-0	Ditto.	1.740	1.510	1.092	1.022	2.000	2.0
Series IX 0-4-0	Ditto.	1.674	1.460	1.280	1.330	1.303	1.4
Series XI (tank engines) 1-4-1	Ditto.	1.794	1.554	1.248	0.988	2.378	2.5
Series IX 0-4-0	Ditto.	1.850	1.358	1 090	1.000	2.030	2.1
Series XII 0-5-0	Ditto.	2 065	1.458	1 390	0.970	2.300	2.6
Series VII (tank engines) 0-3-0	Ditto.	1.160	...	0.936	0.976	1.200	1.2
Series VIII 0-3-0	Ditto.	1.585	1.400	1.067	0.960	1.548	1.6
Series IX (tank engines) 0-4-0	Belpaire.	1.400	1.400	1.100	1.144	1.909	1.9
Series X 0-3-0	Crampton.	1.715	1.600	1.100	1.030	2.401	2.5

TABLE III. *(Continued.)*

Grate area.	Metal used for firebox.	Type of grate			*Remarks.*
		horizontal (H) or inclined (I).	fixed (F) or rocking grate (R).	Position of drop grate.	
France. *(Continued.)*					
Square metres.					
2.71	Copper.	I	Fixed grate	In the middle.	
2.39	Ditto.	I (17°)	Ditto.	...	
2.57	Ditto.	I	Ditto.	In front.	
2.25	Ditto.	I	Ditto.	In the middle.	
2.07	...	I	Ditto.	...	
1.92	Copper.	I (11°45′)	Ditto.	...	
2.50	...	I	Ditto.	In the middle.	
2.10	...	I	Ditto.	In front.	
2.58	...	I	Ditto.	At the back.	
1.26	...	I (12°25′)	Ditto.	...	
1.63	Copper.	I (13°34′)	Ditto.	...	
2.28	Ditto.	H	Ditto.	In front.	
2.59	Ditto.	I (7°06′)	Ditto.	Ditto.	

TABLE III. (*Continued.*)

DESIGNATION OF TYPES OF LOCOMOTIVES.	Types of fireboxes (Description and dimensions).						
	Types of fireboxes.	Height of crown above foundation ring		Inner width		Inner length	
		front.	back.	top.	bottom.	top.	botto
				Eastern Railway Co			
		Metres.	Metres.	Metres.	Metres.	Metres.	Metres
Series XII 1-4-0	Crampton.	2.210	1.610	1.375	0.998	2.666	3.045
Series XII 1-4-0	American.	1.7095	1.6335	1.56	0.961	2.833	3.113
Series VIII^c. Suburban ordinary type (tank engines) 0-3-1	Crampton.	1.628	1.358	1.067	0.991	2.2055	2.260
Series XII. 1-4-0	Belpaire.	2.100	1.570	1.310	1.001	2.674	2.745
Series XI 2-3-0	Ditto.	1.857	1.525	1.062	1.000	2.394	2.484
Series XI 2-3-0	Crampton.	2.005	1.655	1.320	1.020	2.516	2.606
Series XII. 1-5-0	Ditto.	1.880	1.590	1.524	1.560	1.938	2.500
Series XI (locomotives with large driving wheels) 2-3-0	Ditto.	1.745	1.745	1.283	1.090	2.433	3.000
Series XI (locomotives with large driving wheels) 2-3-0	Ditto.	1.811	1 867	1.288	9.88	2.397	2.754
Series VIII^v (locomotives with large driving wheels). 2-2-1	American.	1.980	1.770	1.400	2.050	1.891	2.490
Series XI^c (locomotives with large driving wheels) 2-3-0	Belpaire.	2.227	1.527	1.220	1.005	2.714	3.078
Series XI (« Pacific ») 2-3-1	Crampton.	2.120	1.52	1.375 (front).	1.880 (back).	2.460	2.842

TABLE III. (*Continued.*)

Grate area.	Metal used for firebox.	Type of grate horizontal (H) or inclined (I).	 fixed (F) or rocking grate (R).	 Position of drop grate.	*Remarks.*
ny, France. (*Continued.*)					
quare metres.					
.16	...	I	Fixed grate.	front.	
.99	...	H	R	ditto.	
.26	Copper.	I (13°)	Fixed grate.	ditto.	
.80	Ditto.	I	F	ditto.	
.51	Ditto.	I	F	ditto.	
.68	...	I	F	In the middle.	
.90	..	I	F	ditto.	
.27	Copper.	I	F	ditto.	
.84	...	I	F	ditto.	
.99	...	I	F	ditto.	
.1607	Copper.	I	F	front.	
27	...	I	R	ditto.	

TABLE III. (*Continued.*)

DESIGNATION OF TYPES OF LOCOMOTIVES. (*Categories A, B, C, D.*)	Types of firebox (summary description and dimensions).	Grate area in square metres.
Type B.	Number.	
51	1	1.71
149	1	1.35
302	1	1.79
801	1	1.46
1601 non Compound	1	1.71
1601 Compound	1	1.71
1901	2	2.78
1921	3	3.08
2001	1	1.90
2051	3	1.82
2101	3	1.82
3501	2	2.78
Type C.		
651	4	1.35
701-751	25	1.90
1301	70	2.49
1401	31	2.49
1701	14	2.02
1751	34	2.46
1801	50	2.15
2201	51	2.65
2801	4	2.59
2851	9	2.26

TABLE III. (*Continued.*)

Metal used for firebox.	Type of grate (plan or sketch referred to).	*Remarks.*					
ilways.							
		Firebox dimensions					
		Height above foundation ring		Length		Width	
		Front.	Back.	At top.	At bottom.	At top.	At bottom.
Copper.	Ordinary, with bars : Thickness of bars . . . . . . 20 Space between bars 13	1.520	1.520	1.641	1.702	1.085	1.086
Ditto.	Ditto.	1.528	1.528	1.233	1.230	1.080	1.050
Ditto.	Ditto.	1.575	1.575	1.620	1.660	1.160	1.078
Ditto.	Ditto.	1.610	1.610	1.398	1.446	1.105	1.008
Ditto.	Ditto.	1.705	1.705	1.619	1.702	1.054	1.006
Ditto.	Ditto.	1.705	1.705	1.619	1.702	1.054	1.006
Ditto.	Ditto.	2.030	1.580	2.674	2.742	1.230	0.991
Ditto.	Ditto.	2.030	1.420	2.704	3.077	1.170	0.991
Ditto.	Ditto.	1.590	1.590	1.830	1.900	1.240	1.000
Ditto.	Ditto.	1.690	1.690	1.804	1.892	1.220	0.968
Ditto.	Ditto.	1.690	1.690	1.804	1.892	1.200	0.968
Ditto.	Ditto.	2.025	1.475	2.716	2.802	1.270	0.996
Copper.	Ordinary, with bars : Thickness of bars. . . . . . 20 Space between bars. 13	1.625	1.625	1.264	1.360	1.708	0.991
Ditto.	Ditto.	1.570	1.570	1.838	1.896 1.900	1.274	1.000
Ditto.	Ditto.	1.770	1.270	2.294	2.387	1.080	1.013
Ditto.	Ditto.	1.773	2.248	2.394	2.472	1.076	0.987
Ditto.	Ditto.	1.725	1.475	1.955	2.013	1.046	0.992
Ditto.	Ditto.	1.830	1.330	2.294	2.387	1.080	1.013
Ditto.	Ditto.	1.825	1.380	2.094	2.172	1.065	0.977
Ditto.	Ditto.	1.910	1.530	2.250	2.600	1.320	1.010
Ditto.	Ordinary, with bars : Thickness of bars . . Front 15 Space between bars. . Back. 10	1.514	0.854	2.440	2.488	1.105	1.002
Ditto.	Ordinary, with bars : Thickness of bars. . . . . . 20 Space between bars. 13	1.514	1.119	2.160	2.208	1.105	1.002

TABLE III. (*Continued.*)

DESIGNATION OF TYPES OF LOCOMOTIVES. (*Categories A, B, C, D.*)	Types of firebox (summary description and dimensions).	Grate area in square metres.
		Midi Railway
3001	16	4.02
3051	4	4.02
3101	20	4.00
3701	20	2.65
4001	18	2.80
4101	40	. .
4201	153	...
4501	18	...
5001	47	...
		Paris-Orlea
	Belpaire firebox: Length 2.400 to 3.100 Width 0.972 to 1 000	2.34 to 3.10
	Belpaire firebox: Length 2.842 to 2.875 Width: Front 0.975 to 0.985 — Back 1.680 to 1.880	3.80 to 4.27
	Flat topped firebox: Length 2.250 to 2.707 Width 1.000 to 1.010	2.25 to 2.72
	Flat topped firebox: Length 2.842 Width: Front 0.985 — Back 1.880	4.27
	Round topped firebox: Length 2.441 to 2.443 Width 1.302 to 1.911	3.20 to 4.69
	Round topped firebox: Length 2.337 to 3.123 Width 0.971 to 1.054	2.49 to 3.03

TABLE III. (*Continued.*)

Metal used for firebox.	Type of grate (plan or sketch referred to).	*Remarks.*

ontinued.)

		Dimensions of firebox.					
		Height above foundation ring		Length		Width	
		Front.	Back.	At top.	At bottom	At top.	At bottom.
Copper.	Ordinary bar type : Thickness of bars . . . . 20 Space between bars 13	2.110 2.110	1.510 1.510	2.344 2.344	2.742 2.742	1.370 1.370	Fr. 0.965 B. 1.860
Ditto.	Ditto.	2.020	1.430	3.345	2.745	1.380	Fr. 0.965 B. 1.860
Ditto.	Ditto.	1.910	1.560	2.500	2.600	1.300	1 010
Ditto.	Ditto.	2.060	1.600	2.739	2.776	1.310	1.001
Steel.	Rocking grate : Thickness of bars . . . . 18 Space between bars 12	1.814	1.398	2.300	2.441	1.422	1.302
Ditto.	Ditto.	1.651	1.575	2.798	3.122	1.537	0.972
Copper.	Ditto.	2.050	1.460	2.654	3.075	1.270	0.993
Ditto.	Ordinary bar type : Thickness of bars . . . . 20 Space between bars 13	1.745	1.415	2.620	2.707	1.270	1.000

ilway Company.

Copper or steel	Parallel bar type, Rocking grate.	Locomotives : 1 to 25 — 1701 to 1725 — 171 C to 326 C, 3001 to . . . ,— 4001 to . . . ;— 5001 to . . . ,— 3201 to . . . , — 4201 to . . . , — 5301 to . . . , — 5616 to . . . .
Ditto.	Rocking grate.	Locomotives : 3501 to . . . , — 4501 to . . . , — 6001 to . . . .
Ditto.	Parallel bar type. Rocking grate.	Locomotives : 5501 to 5525. German locomotives (armistice) .
Ditto.	Rocking grate.	Locomotives : 3641 to 3680.
Ditto.	Ditto.	Locomotives : 3591 to 3640, — 5811 to 5960. American locomotives, type A.
Ditto.	Ditto.	Locomotives : 1772 to 1800. American locomotives, type B.

TABLE III. (*Continued*)

DESIGNATION OF TYPES OF LOCOMOTIVES. (*Categories A, B, C, D.*)		Types of firebox (summary description and dimensions).	Grate area in square metres.
			P. L. M. Railw
I. — SHUNTING ENGINES.			
Series.	*Classification.*		
7401-7615	0-3-0	Crampton.	1.36
7701-7750	0-4-0	Belpaire.	2.32
II. — MAIN LINE LOCOMOTIVES (*type B*).			
Series.	*Classification.*		
1513-2397	0-3-0	Crampton.	1.36
3401-3735	2-3-0	Belpaire.	2.48
2430-2599	2-3-0	Ditto.	3.08
2601-2760	2-3-0	Ditto.	2.98
6201-6285	2-3-1	Wooten.	4.25
5301-5550	2-3-2	Belpaire.	2.48
5501-5545	2-3-2	Ditto.	3.08
4001-4172	0-4-0	Crampton.	2.08
401-969	1-4-0	Crampton type, with round topped box.	3.03
3741-3975	1-4-0	Belpaire.	3.08
4295-4499	1-4-0	Ditto.	3.08
4701-4982	2-4-0	Ditto.	3.08
1130-1369	1-4-1	Wooten.	4.25
			Chalosse and Béa
Corpet locomotive		Belpaire Type : Length . . . . 1.406 Width . . . . 0.775 / 0.660 Depth 1.048	0.93

Table III. (*Continued*)

Metal used for firebox.	Type of grate (plan or sketch referred to).	*Remarks.*				
pany.						
		Characteristics of firebox.				
		Heating surface.	Height of crownsheet		Dimensions of upper part	
			front.	back.	length.	width.
		Square metres.	Metres.	Metres.	Metres.	Metres.
Copper.	...	7.04	1.520	1.404	1.290	1.060
Ditto.	...	10.23	1.820	1.220	2.140	1.010
Copper.	...	7.04	1.520	1.404	1.290	1.060
Ditto.	...	12.53	2.020	1.822	2.270	1.230
Ditto.	...	16.00	2.210	1.370	2.840	1.250
Ditto.	...	15.42	2.184	1.372	2.740	1.200
Ditto.	...	15.67	1.995	1.480	2.280	Towards the centre line. 1.516
Ditto.	...	12.53	2.020	1.322	2.270	1.230
Ditto.	...	16.00	2.210	1.370	2.840	1.250
Ditto.	...	9.54	1.795	1.624	1.390	1.290
Steel.	...	15.70	1.710	1.630	2.795	1.536
Copper.	...	16.00	2.210	1.370	2.840	1.250
Ditto.	...	16.00	2.210	1.370	2.840	1.250
Ditto.	...	16.00	2.210	1.370	2.840	1.250
Ditto.	...	15.67	2.000	1.480	2.280	Towards the centre line. 1.516
am Tramways.						
Copper.	Horizontal: Length . . . . 1.406 Width. 0.660					

TABLE III. (*Continued*)

DESIGNATION OF TYPES OF LOCOMOTIVES. (*Categories A, B, C, D.*)	Types of firebox (summary description and dimensions).		Grate area in square metres.
			Chalosse and Bé
Superheated steam locomotive	Belpaire type :	Metres.	0.97
	Length	1.015 1.044	
	Width	0.900 0.960	
	Depth	1.100	
			Railways of
Locomotive of 18 tons light weight	...		0.86
Locomotive of 22 tons light weight	...		1.00
			Landes L
Engines 1 to 12 (Landes)	Crampton firebox :		0.84
Internal height	Front	1.280	
	Back	1.280	
Internal length	Top	0.823	
	Bottom	0.865	
Internal width	Top	0.928	
	Bottom	0.968	
Thickness	Crownsheet	0.013	
	Sides	0.013	
	Back	0.013	
	Tube plate	0.013 0.025	
Engines 21 to 24 (Born and Marensin)	Belpaire firebox :		1.00
Internal height	Front	1.285	
	Back	1.085	
Internal length	Top	0.925	
	Bottom	0.980	
Internal width	Top	0.960	
	Bottom	1.005	

TABLE III. (*Continued*).

Metal used for firebox.	Type of grate (plan or sketch referred to).	*Remarks.*
am Tramways (*Continued.*)		
Copper.	Horizontal : Length . . . . 1.015 Width 0.960	
n Département.		
Copper.	Cast iron.	
Ditto.	Ditto.	
lways:		
Copper.	Horizontal grate : Length . . . . 0.865 Width 0.968	
Copper.	Grate inclined at 27.4 °/o. Length measured along slope. 0.995. Width : 1.005.	

TABLE III. (*Continued.*)

DESIGNATION OF TYPES OF LOCOMOTIVES. (*Categories A, B, C, D.*)	Types of firebox (summary description and dimensions).	Grate area in square metres.
		Landes Local
Thickness	Metres Crownsheet . . . . 0.013 Sides. . . . . 0.013 Back . . . . 0.013 Tube plate . . . . 0.013 / 0.025	... ...
		Railways of
Class *C*.	Round topped firebox : Length. . . . . 1.275 Width 1.115	1.42
Class *D*	Belpaire firebox : Length. . . . . 0.855 Width 1.000	0.86
		Algerian S
Type C. — Standard gauge	Of copper.	...
Old type 0-3-0. Series 1 to 135. (Arrondissement of Algiers).	Crownsheet with roof bars. Heating surface of firebox : 7 m² 74	1.341 × 1.001 = 1
Old types 0-3-0 and 1-3-0. Series 101 and 1 t. (Arrondissement of Bône)	Crownsheet with roof stays. Heating surface of firebox : 7 m² 40	1.500 × 1.000 = 1
Fairly recent. Type 2-3-0. Series 211 to 267	Crownsheet with roof stays. Heating surface of firebox : 10 m² 95	2.300 × 1.012 = 2
Recent. Type 1-5-0. Series 521 to 550	Crownsheet with roof stays. Heating surface of firebox : 15 m² 80	2.860 × 0.951 = 2
		Tunisian
Standard gauge.		
B (Series 81)	Firebox fixed between the frames ; round top with roof stays. Brick arch, 9 m² 29 direct heating surface.	1 30
C Series 181.	Belpaire with roof stays. Arch, 16 m² 05 of direct heating surface.	2.72
C Series 221.	Belpaire with roof stays. Arch, 15 m² of direct heating surface.	2.72

TABLE III. (*Continued.*)

Metal used for firebox.	Type of grate (plan or sketch referred to).	*Remarks.*
ys (*Continued.*)		
...	...	
...	..	
...	...	
...	...	
stern Pyrenees.		
Copper.	...	
Ditto.	Bar grate.	
ilways.		
Copper.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
y Company.		
Copper.	Inclined grate with drop grate.	American two-cylinder engines.
Ditto.	Ditto.	Superheated steam express engines, 4 cylinders.
Ditto.	Ditto.	Superheated steam engines.

TABLE III. (*Continued.*)

	DESIGNATION OF TYPES OF LOCOMOTIVES. (*Categories A, B, C, D.*)	Types of firebox (summary description and dimensions).	Grate area in square metres.
			Tunisian Railw
D	Series 1	Firebox between frames, round crownsheet with roof bars 6 m^2 08 direct heating surface.	1.25
	Series 1 rebuilt.	Belpaire firebox between frames, with roof stays, 7 m^2 15 direct heating surface.	1.50
	Series 2001.	Firebox between frames, with roof stays, 4 m^2 37 direct heating surface.	0.97
	Narrow gauge.		
C	Series 301	Firebox between frames, round crownsheet with roof bars 3 m^2 63 direct heating surface.	0.7137
	Series 351	Firebox between frames, round crownsheet with roof bars, 3 m^2 64 direct heating surface.	0.73
	Series 451	Belpaire firebox between frames, with roof stays 6 m^2 18 direct heating surface.	1.02
	Series 501	Belpaire firebox between frames, with roof stays, 7 m^2 60 direct heating surface.	1.22
	Series 551	Belpaire firebox between frames, with roof stays 9 m^2 82 direct heating surface.	1.55
	Series 681	Round topped firebox with roof stays, 9 m^2 51 direct heating surface.	1.51
	Series 701	Belpaire firebox between frames, with roof stays, 8 m^2 60, direct heating surface.	1.43
	Series 751	Ditto.	...
	Series 801	Belpaire firebox between frames, with roof stays 8 m^2 95 direct heating surface.	2.20
D	Series 401	Firebox between frames, round crownsheet with roof bars 5 m^2 direct heating surface.	0.9148
	Series 1021.	Round topped firebox, between the frames, with roof stays 4 m^2 80 direct heating surface.	1.23

TABLE III. (*Continued.*)

Metal used for firebox.	Type of grate (plan or sketch referred to).	*Remarks.*
npany. (*Continued.*)		
Copper.	Horizontal grate, without drop grate or arch.	Simple expansion.
Ditto.	Inclined grate, drop grate and arch.	Ditto.
Ditto.	Horizontal grate, without drop grate or arch.	Ditto.
Ditto.	Ditto.	Ditto.
Ditto.	Inclined grate, without drop grate or arch.	Ditto.
Ditto.	Ditto.	Mallet compound engines.
Ditto.	Inclined grate, without drop grate and arch.	Simple expansion.
Ditto.	Ditto.	Mallet compound engines.
Ditto.	Horizontal rocking grate, American type, with drop grate and arch.	American compound engines.
Ditto.	Ditto.	Simple expansion.
Ditto.	Ditto.	Express superheated steam engines.
Ditto.	Ditto.	
Ditto.	Inclined grate, without drop grate or arch.	Simple expansion.
Ditto.	Inclined grate with drop grate and without arch.	Ditto.

TABLE III. (*Continued.*)

DESIGNATION OF TYPES OF LOCOMOTIVES. (*Categories A, B, C, D.*)	Types of firebox (summary description and dimensions).	Grate area in square metres.
		Franco-Ethiop
C		
Simple expansion locomotives with tender. 6 coupled with bissel bogie. 1 m. 200 wheels.	Round topped box. Firebox crown, direct stayed; stays of manganese-copper.	1.09
Superheated steam locomotives with tender. 6-coupled with bissel bogie. 1 m. 200 wheels.	Ditto.	1 09
Compound locomotives with tender. Saturated steam. 8-coupled with bissel bogie. 1 m. wheels.	Ditto.	1.29
Superheated steam locomotives with tender. 8-coupled with bissel bogie. 1 m. wheels.	Ditto.	1.50
D		
Simple expansion tank-engines. 6-coupled. 0 m. 800 wheels.	Ditto.	0.791
Simple expansion tank-engines. 6-coupled. 0 m. 850 wheels.	Ditto.	0.66
	General Administration of Railways and Public Wor	
C		
Rack locomotives. Narrow gauge (1 m. 05)	Firebox without brick arch. Firebox crown inclined towards the rear so as to be horizontal on gradients of 7 %. 10 m² of heating surface.	2.10
D		
Adhesion locomotives. Narrow gauge (1 m. 05). .	Firebox without arch. Firebox crown inclined towards the rear so as to be horizontal on gradients of 3 %. 7 m² 03 of heating surface.	1.40
B		
Superheated steam locomotives	Brick arch in firebox. Swinging drop grate. 14 m² 90 of heating surface.	2.60

TABLE III. (*Continued*)

Metal used for firebox.	Type of grate (plan or sketch referred to).	*Remarks.*
lway Company.		
Copper.	Iron grate.	For 1 m. gauge.
Ditto.	Ditto.	Ditto.
Ditto.	Ditto.	Ditto.
Ditto.	Ditto.	Ditto.
Ditto.	Ditto.	Ditto.
Ditto.	Ditto.	Ditto.
ascus-Hamah Railway and Extensions.		
Copper.	Formed of a variable number of sets of four shaped iron firebars, separated by wedge shaped washers and rivetted together.	
Ditto.	Ditto.	
Ditto.	Ditto.	*Note.* — The length of the firebars is half that of the firebox except on locomotives fitted with a transverse drop grate, the width of which has to be deducted.

TABLE III. (*Continued.*)

DESIGNATION OF TYPES OF LOCOMOTIVES. (*Categories A, B, C, D.*)		Types of firebox (summary description and dimensions).	Grate area in square metres.
		General Administration of Railways and Public Wor	
C.	50 to 59 0-3-0	...	1.60
	61 to 69 2-3-0	...	1.85
	101 to 112 1-4-0	...	2.40
	G 8 0-4-0	...	2.35
	G 10 0-5-0	...	2.60
	41 to 47 2-4-0	...	2.00
D.	31 to 35 0-3-0	...	1.50
			French West Afri
D.		...	18 t. 0.8
		...	30 t. 1.4
		...	37 t. 1.1
			French West Afri
D.		...	12 t. 0.5
		...	20 t. 0.8
		...	32 t. 1.1
			Kayes-Nig
C.	47 t.	Type of locomotive with inclined grate and drop grate.	1.55
D.	27 t.		1.40
	26 t.	Ditto.	1.03
	18 t.	Ditto.	1.00
	15 t.	Type of locomotive with horizontal grate and without drop grate.	0.625
	10 t.		0.638
	10 t.		0.520

TABLE III. (*Continued.*)

Metal used for firebox.	Type of grate (plan or sketch referred to).	*Remarks.*
yrna-Cassaba Railway and Extension.		
Copper.	...	Superheating.
Ditto.	...	Compound. Saturated steam.
Ditto.	...	Superheating.
Ditto.	...	Superheating.
Ditto.	...	Superheating.
Ditto.	...	Saturated steam.
Ditto.	...	Saturated steam.
iomey Railways.		
Copper.	Separate bars.	
Ditto.	Ditto.	
Ditto.	Ditto.	
iomey Eastern Railways.		
Copper.	Separate bars.	
Ditto.	Ditto.	
Ditto.	Ditto.	
lway.		
Copper.	Ordinary grate and drop grate. Cast iron bars.	
Ditto.		
Ditto.		
Ditto.		
Ditto.	Ordinary grate, iron bars.	
Ditto.		
Ditto.		

TABLE III. (*Continued.*)

DESIGNATION OF TYPES OF LOCOMOTIVES. (*Categories A, B, C, D.*)	Types of firebox (summary description and dimensions).	Grate area in square metres.
		Kayes-Ni
E. Rail motor car	Vertical boiler. Water-tube firebox, dry pipe. (Supplied by Robatel and Buffaud, Lyons).	...
		Konakry-Ni
Type C	Copper firebox, inclined at angle of from 7 to 12° towards the front.	from 0.70 to 1.55
		Reggio-Em
Class *C*	Rectangular firebox : Length. . . . . 1 m. 402 Width . . . . . 1 m. 052 Height of firebox crown . 1 m. 050	1.475
Class *D*	Rectangular firebox : Length. . . . . 1 m. 910 Width . . . . . 0 m. 884 Heigth of firebox crown . 0 m. 980	0.804
		Railways of
Type 8620 (2-6-0)	Narrow firebox.	1.63
Type 18900 (4-6-2)	Wide firebox.	2.53
Type 9600 (4-8-01)	Ditto.	2.33
Type 9900	Ditto.	3.25
		Dut
A 2100	...	2.40
3700	...	2.84
B 3400	...	2.20
C 7400	...	1.16
D 8700	...	1.47

TABLE III. (*Continued.*)

Metal used for firebox.	Type of grate (plan or sketch referred to).	*Remarks.*
ilway. (*Continued.*)		
Steel tube with firebrick lining	Rocking grate and drop grate.	
ilway.		
Copper.	Composed of sets of 3 iron bars, 100 × 10 mm., the bars being fixed 20 mm. apart.	
ilway.		
...	...	
...	...	
panese Imperial Government.		
Extra soft steel.	Rocking grate.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
ilways.		
Copper.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	

TABLE III. (*Continued.*)

DESIGNATION OF TYPES OF LOCOMOTIVES. (*Categories A, B, C, D.*)	Types of firebox (summary description and dimensions).	Grate area in square metres.
		Dutch E
Gauge : 1 m. 435.		
A.	*Upper surface of firebox.*	
81-86.	Inclined at 2.84 $^0/_0$.	1.90
10-33.	Horizontal.	1.38
89-94.	Inclined at 2.84 $^0/_0$.	1.90
87-88.	Inclined at 2.84 $^0/_0$.	1.90
B.		
61-64.	Inclined at 1.37 $^0/_0$.	2.58
51-57.	Inclined at 2.52 $^0/_0$.	2.00
Gauge : 1 m. 067.		
B.		
371-400	Horizontal.	1.80
250-263	Horizontal.	0.90
351-360	Inclined at 1.90 $^0/_0$.	1.275
C.		
331-339	Horizontal.	0.87
306-325	Horizontal.	0.90
271-285	Inclined at 6.40 $^0/_0$.	1.80
231-235	Inclined at 6.30 $^0/_0$.	1.44
		Dutch East Ind
Types :	*Ordinary firebox.*	
C. 1C-II	738 × 1.500	1.107
C. 1C-II-C	738 × 1.500	1.107
C. B+B-1-IV-C-A	708 × 2.050	1.45
B. 1C+C-IV-C-A	950 × 2.150	2.04
B. 1F-1-II-S	1.300 × 2.000	2.60
B. 1D+D-IV-C-S-A-*t.*	1.530 × 2.744	4.15
C. 2B-II-C-*t*	736 × 1.766	1.33
C. 2B-II-S-*t*	736 × 1.766	1.32
B. 2C-1-II-S-*t.*	1.262 × 1.850	2.30
B. 2C-2-II-S (series 1100)	1.224 × 1.472	1.85
B. 2C-II-S (series 1300)	1.700 × 1.770	3.00
B. 2C-S-IV-C-S-*t*	1.400 × 1.925	2.70
B. 1D-II-S-*t*	1.300 × 1.730	2.25
B. 1D-1-II-S	1.300 × 1.850	2.40
B. 1D-1-II-S-*t.*	1.262 × 1.980	2.50
D. Various types of small models	737 × 616 to 737 × 144	0.42 to 1.12

TABLE III. (*Continued.*)

Metal used for firebox.	Type of grate (plan or sketch referred to).	*Remarks.*
dian Railways.		
Copper.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
ilways. — Java.		
Copper.	Ordinary grate.	*Abbreviations :* A = Articulated locomotive. C = Compound. S = Superheater. *t* = Tender. II and IV = Number of cylinders.
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Rocking grate.	
Ditto.	Ordinary grate.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Rocking grate.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ditto.	
Ditto.	Ordinary grate.	
Ditto.	Ditto.	

TABLE III. (*Continued.*)

DESIGNATION OF TYPES OF LOCOMOTIVES. (*Categories A, B, C, D.*)	Types of firebox (summary description and dimensions).	Grate area in square metres.
		Swiss Feder
A		
Nil.		
B	Length. Width. Height.	
Locomotive A 3/5, No. 603-649	2.799 × 1.010 × 1.973	2.80
— A 3/5, No. 701-809	2.410 × 1.034 × 1.960	2.60
— A 3/5, No. 931-938	3.120 × 1.070 × 1.815	3.34
— B 3/4, No. 1301-1339	2.340 × 974 × 1.800	2.30
— B 3/4, No. 1601-1747	2.250 × 974 × 1.840	2.30
— C 4/5, No. 2601-2619	2.340 × 974 × 1.935	2.44
— C 4/5, No. 2701-2732	2.508 × 974 × 1.935	2.44
— C 5/6, No. 2951-2978	2.170 × 1.710 × 1.970	3.80
— E*b* 3/5, No. 5801-5834	2.340 × 974 × 1.750	2.30
— E*c* 3/3, No. 6401-6412	1.200 × 1.040 × 1.240	1.27
— E*c* 3/4, No. 6501-6592	1.770 × 970 × 1.480	1.70
— E 3/3, No. 8384-8662	1.262 × 938 × 1.290	1.17
— E 4/4, No. 8851-8856	1.458 × 1.034 × 1.495	1.50
		Railways of t
B.	Maximum dimensions (internal) : Length . . . . 2 100 mm. Width. . . . . 1 890 mm. Height at front . . . . 1 750 mm. Height at back . . . . 1 550 mm.	4.00
B.	Maximum dimensions (internal) : Length . . . . 2 720 mm. Width. . . . . 1 540 mm. Height at front . . . . 1 721 mm. Height at back . . . . 1 458 mm.	4.2
B.	Maximum dimensions (internal) : Length . . . . 1 700 mm. Width. . . . . 1 220 mm. Height at front. . . . 1 640 mm. Height at back. . . . 1 400 mm.	2.06

Table III. (*Continued.*)

Metal used for firebox.	Type of grate (plan or sketch referred to).	*Remarks.*
ilways.		
Copper.	...	Old locomotives have been fitted with rocking grates.
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	..	
Ditto.	...	
Copper and iron.	..	
Copper.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
Ditto.	...	
echoslovakian Republic.		
Copper.	...	Locomotives of series 365.0
Ditto.	...	Locomotives of series 534.0.
Ditto.	...	Locomotives of series 423.0.

Summary of replies received.

Question a. — Choice of fuel.

Regulations. — Reception of deliveries. Inspection and testing.

A detailed examination of the general conditions laid down in respect of the supply of fuel on the various railways consulted leads us to classify them in two main categories.

Certain railways only require their suppliers to comply with a very limited number of special conditions, and attach more importance to the source from which the fuel is derived. They endeavour, therefore, in the first place to ascertain the particular qualities of fuel from the various mines from which they may procure supplies. This is done either by laboratory analyses or by practical tests; and at the time of delivery all that is done is to check the source from which the supplies have come, subsequent analyses and actual working results being sufficient to show whether the quality of the fuel remains constant.

Some railways, on the other hand, stipulate that the fuel supplied to them shall fulfil numerous and precise conditions, for instance as regards the percentage of ash, of volatile matter and of moisture, fusibility of ash, etc. These conditions generally amount to fixing definite maximum and minimum figures, and consequently fuel which does not come within such limits may be rejected.

It would appear desirable, therefore, first of all to compare the above two systems, and to ascertain to what extent it is in the interests of the large fuel consuming railways to insist on the observance of certain more or less rigid conditions on the part of their suppliers.

It is evident that in principle locomotives must be designed and handled with a view to the most economic utilisation possible of that fuel which can be obtained in sufficient quantity and from as near a source as possible; and further that it would not be reasonable to construct, *a priori*, a certain type of firebox, and then to endeavour to procure, either at home or abroad, the fuel appropriate for use in that particular type of firebox, without regard to the price of such fuel.

There is no reason to believe that any railway would think of adopting such a principle as the latter. Certain railways, however, coming within the category of those who purchase according to origin and without laying down any special conditions, consider that every condition imposed necessarily limits the market, and in addition creates in a given coal market an excessive demand for certain qualities of fuel, resulting in a relative scarcity of such qualities and a corresponding increase in price.

Are these apprehensions justified? In general, any coal market offers a large selection of qualities, and whatever be the type of locomotive firebox in use, it is always possible, by means of appropriate mixing of different kinds of fuel, to obtain a product which will meet requirements. It appears, therefore, that the fixing of conditions *according to the qualities available*, not only does not restrict the market but tends to enlarge it much more than would be the case under the system of buying according to origin.

Apart from this objection, which cannot be considered entirely well founded, it would appear desirable to lay down very precise conditions with regard to the supply of fuel, *even in cases where the* *latter is derived from well-known mining districts with which the railway is connected by geographical, commercial or political ties.*

In order to show the advantages which this method presents, we will review some of the more essential conditions which should be laid down, even in cases where at first sight they might not appear indispensable that is to say in the case of railways which always derive their supplies from the same pits or mining districts.

Size of fuel. — It is necessary to specify the various proportions making up the composition of a delivery. As the majority of mines split up their products in order to sell them either separately or in mixtures, it is necessary to specify (and to verify by screening tests at the time of delivery) the size of each of the kinds of coal contained in the delivery. The different sizes of coal, which have very different market values, have also different degrees of value as regards their use in locomotive fireboxes.

It is quite certain that the mere guarantee of origin would not protect the railway against fluctuations in the composition of deliveries which the supplier might find it in his interests to resort to at certain periods.

Percentage of ash. — Here again the guarantee of origin is no safeguard of the purchaser's interests, as this percentage is not always the same even in the same pit.

The sorting and re-mixing of the various sizes may also affect this percentage. The coal deposits may vary considerably in one and the same pit. Methods of extraction may change, and the use of certain mechanical tools may give less clean products (*i. e.*, containing more foreign matter) than other coal-cutting appliances or than the use of the pick. Finally, the sorting and washing of the coal may be more or less thorough, and the mixing with washed coal may greatly affect the ultimate percentage of ash for the whole delivery.

Percentage of moisture. — The increasing proportion of washed coal entering into the composition of deliveries makes it more than ever necessary to ascertain the quantity of water contained in the fuel supplied (1).

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It would appear, therefore, that these essential conditions with regard to composition, percentage of ash and percentage of moisture should be insisted upon in all cases, and that their observation should be carefully verified in the case of each delivery.

We will now consider the advantages to be derived from the adoption of regulations with regard to other conditions.

Percentage of volatile matter, percentage of sulphur, fusibility of ash, friability, caking capacity. — Like the three elements already considered (composition, ash, moisture), these further characteristics are of the highest importance as regards the output and maintenance of fireboxes and boilers, and the punctuality, speed and load of trains. It is superfluous to insist on this point, and it goes without saying that the railways which, by reason of their geographical situation, have at their disposal a variety of kinds of fuel, will ascertain and lay down for each of these characteristics such a standard as will ensure the most efficient possible output.

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(1) Here, as with ash and other inert, incombustible matter, the least disadvantage of which is that it must be transported and handled at a pure loss. This question is, therefore, of particular importance to railways situated at a considerable distance from mining districts, the net cost of their fuel being particularly influenced by the cost of transport. It is precisely among these railways that we find a tendency to neglect the enforcing of special conditions and to rely entirely on the guarantee of origin.

Perhaps this state of affairs arises from the fact that, being situated at a distance from the mining districts, these railways are dependent on some particular district, which is thus in a position more or less to dictate its own conditions and would not submit to too irksome requirements. No explanation of the fact is, however, volunteered by any of the railways in question.

The twofold problem, consisting on the one hand in the limits of the fuel available, and on the other in the necessity of taking into account the exigencies of the various types of fireboxes, boilers, locomotives, or nature of traffic, renders it impossible to fix uniform limits for the various characteristics under consideration. We shall, therefore, confine ourselves to noting the special requirements of the individual cases as set out in the documentary part of this report.

We consider it necessary, however, to insist on the considerable relative importance of fixing the percentage of volatile matter at a suitable figure. If, in fact, the intensity of consumption per square metre of grate area, and the necessity of a satisfactory degree of caking, lead to the use of fuel high in volatile matter, account must be taken of the loss through incomplete combustion of the hydrogen, which loss increases rapidly in proportion as the activity of combustion increases. Exhaustive boiler tests have shewn that this loss may be as high as 27 % of the calorific value of the coal with a consumption of 640 kgr. per square metre (131.1 lb. per square foot) per hour. The information supplied by the railways would appear to show that they generally fix the percentage of volatile matter between somewhat wide limits, whereas it appears highly desirable to narrow the limits.

However this may be, and although it may be taken that the various conditions contemplated above will be imposed by the majority of railways, it may be asked whether companies which limit their requirements to a guarantee of origin of the fuel supplied to them, have an equal interest in imposing such conditions. In other words, whereas, as has been remarked above, it appears desirable for these railways to impose (in addition to verification of origin) conditions relative to composition, percentage of ash and percentage of moisture, is it as necessary for them to add to these three conditions the further ones relative to volatile matter, sulphur, friability, fusibility of ash, and caking capacity? It seems indeed that except for pits which contain different classes of deposits, these characteristics are generally constant in fuel from a given source, and that therefore it would be superfluous to specify them, as the given source will presumably always supply fuel with identical characteristics.

It appears desirable, however, that these additional conditions should be stipulated, as they are likely to encourage competition. Collieries or competing coal contractors, knowing exactly the *limits* applicable to each of the characteristics of fuel suitable for a given railway, will be in a better position to give prompt and precise quotations.

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To summarise : it appears desirable, *in all cases*, to fix precise limits for the various characteristics of coal referred to above. In the case of briquettes, of course, there should be an additional regulation with regard to the degree of friability.

Certain railways also add conditions relative to calorific value, and even with regard to evaporative capacity (ascertained either in a stationary boiler or on a locomotive in service).

No railway has given a definite opinion as to the desirability of laying down such conditions.

As regards the calorific value, however, it would appear that the various characteristics referred to above already sufficiently define the nature of the fuel. The fixing of the calorific value is therefore unnecessary. Further, the calorific value, as determined by one or other of the various practical methods generally adopted in our laboratories, is of a less absolute character than the results of the analyses with regard to the ordinary characteristics of fuel.

As for the evaporative capacity, as obtained with a stationary boiler, this element is so uncertain, and so dependent on factors which have noting to do with the nature of the fuel, that it does not appear capable of defining in any way the quality of the fuel. Even if the tests are carried out in stationary boilers fitted with accurate measuring apparatus, the evaporation obtained will depend — to mention only the more important factors — on :

1° the type of firebox chosen;
2° the standard of firing;
3° the nature of the steam;
4° the degree of cleanliness of the boiler;
5° the degree of cleanliness of the tubes;
6° the state of the grate and of the firebox;
7° the capabilities of the fireman and driver.

All these factors have nothing to do with the intrinsic quality of the fuel. If, then, we only consider the single factor of the capability of the fireman, it must be recognised that he can vary the evaporation between very wide limits. It was found, on the occasion of a stoking competition at the Universal Exhibition at Liége in 1905, that the variation in results, measured in terms of steam produced, between the first and the last fireman of each class, was as much as 43 %. But these firemen worked under conditions which were as nearly as possible identical *and used the same coal.*

If, therefore, we consider the additional factors which come into play in an evaporation test *carried out on the road* (to which factors must be added the consideration that the operations take place under much less favourable conditions), we must realise that it is impossible to estimate the exact value of a given kind of fuel by such means.

Reception of deliveries. — The organisation of this branch of the service, the taking of samples, their preparation and analysis, often depend on local circumstances, as will be seen on reading the documentary section of the report. It appears essential to specify precisely, in the standing regulations or in contracts entered into with fuel suppliers, the methods to be adopted for taking samples, preparing them and analysing them. The results obtained by these operations depend frequently on the method adopted, and their value, therefore, is relative rather than absolute.

The fuel laboratory of a railway must first of all be equipped to enable it to verify the various characteristics enumerated above. Even when these characteristics are not taken to include the calorific value of the fuel or its evaporative capacity, it would appear necessary that the laboratory should be in a position to ascertain these additional characteristics if required.

In the absence of a fixed locomotive, the laboratory should at least possess one or more stationary locomotive boilers with which exact evaporation tests can be carried out. These tests should be so arranged as to give in each case a complete calorific chart which should be as detailed and exact as possible.

The object of these tests should be to determine, in a given case, the influence of any particular factor which is capable of modifying the output of fireboxes or boilers. Thus, tests may be made to ascertain, under the particular conditions existing on a given section of the railway, the influence exercised respectively by the smokebox vacuum, the depth of the fire, the frequency of firing, the various types of grate in use, the area between their bars, their dimensions, the dimensions of the arches and deflectors, the air inlets, the metal of which the fireboxes or tubes are made, the dimensions of the tubes, their length and number, the degree of cleanliness of the boiler and tubes, etc., etc. Although numerous investigations and tests have been carried out in this connection on many occasions, the influence which may be exercised on the results obtained, by the *local circumstances* peculiar to a railway, is such that generalisations based on such inquiries may often be misleading. If, now, we consider the large proportion of the total working expenses of a railway attributable to the fuel consumption, the cost of providing the requisite installation and equipment for testing purposes appears relatively trifling.

In addition to the ordinary tests, possession of such equipment makes it possible to determine exactly, prior to use on a service locomotive, the value of any form of apparatus or new system likely to improve the output of fireboxes or boilers; *e. g.* grates, firedoors, smoke consuming devices, tools for cleaning grates and tubes, fuel injectors, etc.

But (and it is in this connection that the provision of his equipment is most important) with these facilities it is above all possible to determine the characteristics which the different kinds of fuel must possess if they are to be satisfactory for the use to which they are to be put. The equipment will be used to determine the kinds of fuel most suitable for the various types of locomotives and trains. It will not be used to determine the value of a given kind of fuel *after* delivery, but will, *before* the delivery is made, determine characteristics which the fuel to be supplied must possess.

As it has been stated above, the vaporisation figure is only one of many factors in the complete calorific chart obtained in a complete test. It is, however, an essential factor, and an attempt should be made to render its value as high as possible by determining which kinds of fuel possess the most favourable characteristics (volatile matter, size, etc.) and by choosing the methods of heating best adapted to each kind of fuel.

Finally, the possession of this equipment will make it possible to ascertain what are the most suitable mixtures of the different kinds of fuel.

Inspection and testing.— However carefully the question of the conditions to be laid down in respect of the various kinds of fuel may have been considered, and however carefully and minutely the verification tests may have been carried out, it is above all essential that the organisation of the fuel supply service should be judged by the results obtained under actual working conditions; and all railways appear to be unanimous in recognising this principle. These tests, which are more qualitative than quantitative, constitute the most effective method of ascertaining the value of the fuel purchased, because such tests are continuous and are carried out by employees who are independent of the fuel reception service, and further because the drivers have a personal interest in seeing that they are supplied with satisfactory fuel. Further, the practical tests sometimes reveal peculiarities in certain kinds of fuel which escape the ordinary laboratory or fixed installation tests.

Purchases and fixing of prices. — The constant fluctuations and the instability of the fuel market since the war are such that the contracts entered into by the various railways for the supply of fuel vary considerably in form. It is not possible in this respect to deduce any rule or general principle from the information which has been supplied to us.

It may, however, be pointed out that several railways, and in particular the majority of the French companies, and the Belgian State Railways, make the price of fuel depend upon the percentage of moisture and ash. The price being fixed on the assumption of certain standard percentages, the actual price paid depends upon the actual percentages as ascertained on delivery.

This method appears to us reasonable, equitable, and above all in the interests of the railways. It is reasonable because once the particular characteristics which determine the nature of a given kind of fuel are definitely known (volatile matter, size, caking capacity, fusibility of ash, friability, percentage of sulphur, etc.), its real value can then only depend in the majority of cases on the proportion of inert and incombustible matter which it may contain, that is to say, moisture and ash.

As regards moisture, the percentage generally varies within very wide limits, often reaching as much as from 10 to 12 % in the case of washed coal. If it is intended that the prices fixed at the time of signing a contract shall retain any validity, it appears essential to determine the weight of water contained in the delivery; the least that can be done, to be strictly fair, is to deduct this weight purely and simply from the gross weight of the delivery. Even in this way the purchaser is not completely indemnified, since he will have had to bear the unproductive expense of transporting and handling this useless weight of excess water. It is, however, possible to find a certain compensation for this by not allowing any premium, as is done by certain railways, in cases where the percentage is below the standard figure.

As regards the percentage of ash, the loss here may be considerably greater, and in this case it is not sufficient merely to deduct the weight of ash from the gross weight of the fuel delivered. If it were desired to ascertain the total loss due to ash, it would be necessary first of all to take into account the following factors :

1° cost of transport of the ash contained in the coal;
2° cost of handling the ash;
3° cost of attention to ashpans;
4° loss through unburnt matter;
5° loss of heat contained in the ash.

These losses alone are already sufficiently high. They occur in all fixed installations; but in the case of railway work it is necessary also to take into account the following still more important factors :

1° diminution of firebox output;
2° reduction of the length of journeys which can be made without prolonged stops, with a corresponding reduction in

the amount of work executed by the locomotives;

3° finally, and especially, increased likelihood of irregular running due to insufficient steam pressure.

It is very difficult, if not impossible, to reduce these various factors to exact figures. We will just remark that in general the penalties imposed for each unit per cent of excess ash range from 1.5 to 2.5 % of the cost of the fuel.

Mixtures. — The majority of the railways use mixtures of different classes of coal. By the use of these mixtures it is possible to avoid the defects of the individual classes, provide a standard form of fuel of known characteristics, and, by enabling the railways to purchase very varied kinds of coal, enlarge the available market and the purchasing facilities.

The absolute necessity of obtaining perfect uniformity in the mixed product (without which uniformity the product would not possess in practice the qualities contemplated when fixing the proportions of its component parts) makes it essential to use mechanical mixers.

The question then arises, however, as to where these mixers should be installed. Certain railways do the mixing in the engine sheds themselves, and the mixed product, on leaving the mechanical plant, falls directly into the tender. Others prefer to instal the plant at various points on the railway in a very limited number of mixing centres, whence the « manufactured » coal is distributed to the various fuel depots.

At first sight the former method appears preferable, the cost of handling the coal and loading it on the tender being reduced to a minimum. It must not be forgotten, however, that the increased cost of handling and transport which appears to result in the second case is counterbalanced first of all by the fact that the number of mixers is reduced, the cost of installation is lower, and the output of the plant is greater. It follows that the cost of the actual mixing is lower in the second case than in the first. Further, when mixed, the coal to be despatched to the fuel depots can be loaded in special wagons (hopper wagons, for example) suited to the particular system adopted at the coal depots for loading the coal on to the tenders. This means that the coal arrives as directly as possible on the tender, without intermediate storage. Finally, even if there were a slight difference in the cost, it would be possible to reduce it to a minimum by locating each mixing centre at an important fuel depot, whereby the coal could always be loaded directly on to the tender, at any rate in the case of engines which take in coal at such depots.

The factor, however, which appears necessarily to dominate the whole question, is the quality of the mixture. It is evident that the mixture cannot combine in itself the desired qualities unless it is made up in the correct proportions. To effect this, a railway must have at its disposal coal of different kinds, from various sources, in sufficient quantity to enable it at all times to make mixtures of the required quality. Such mixtures must satisfy numerous conditions, particularly as regards size, volatile matter and ash. It may also be necessary to mix different kinds of coal which have varying percentages of ash; and this must be done in such a manner that the defects of the individual kinds of coal shall disappear in the mixed product. Finally, the caking capacity of certain kinds of coal must sometimes be taken into account in fixing the composition of a mixture.

The factors which must be taken into

account in fixing the various kinds of coal which are to enter into a given mixture are, therefore, numerous, and may indeed in certain cases be contradictory. When the mixers serve only one engine shed, their daily consumption and the quantity held in reserve necessarily depend on the consumption of the engine shed and are consequently strictly limited. A mixing centre, on the contrary, should have at its disposal such supplies of coal (as regards both quantity and quality) as will, in spite of the irregularity which inevitably occurs in deliveries and in the quality of the fuel supplied, enable the centre at all times to produce a satisfactory mixture.

Size of stocks. — The size of stocks varies from railway to railway, and appears to depend above all on the distance of the source from which supplies are derived. No railway keeps less than one month's reserve. It appears, further, that, apart from such considerations as may lead a railway to stock large quantities of fuel at a certain period of the year, the mere consideration mentioned above with respect to mixing centres is sufficient to lead to the conclusion that a month's reserve must be considered a strict minimum. A large coal depot is costly, it is true, on account of the idle capital which it represents, the ground it occupies and the plant which it comprises, the loss (which must not, however, be over-estimated) in calorific value of the fuel kept in stock, and the danger of heating in the case of small coal kept in large stacks; but it does not require much consideration to realise that these disadvantages are practically negligeable in comparison with the increased expenditure resulting from the use of fuel which is not suitable for the types of firebox in use.

Geographical position of the fuel depots. — This question is only of importance in the case of central depots (mixing centres, for example), whose situation on a railway system depends firstly on the points to which fuel can be delivered by the suppliers, and secondly on the points most suitable for feeding locomotives.

Net cost. — The information supplied to us on this subject by the various railways consulted does not lend itself to any kind of comparison. The units selected vary considerably : train-kilometre, locomotive - kilometre, locomotive - kilometre with train, ton-kilometre, virtual ton-kilometre. It follows that though a statistical table of consumption, drawn up periodically, may be of relative value to the railway concerned, it may be meaningless to other railways.

A standardised form of statistics would be of immense value to all railways, for it might frequently reveal the influence of a given predominating factor, and would constitute a decisive argument in a large number of technical discussions.

If an attempt is to be made to arrive at the elements of a standardised form of statistics, it will be necessary first of all to determine the results of working in such a way that their significance shall be as absolute as possible. These elements must, therefore, be independent, if possible, of the characteristics peculiar to each individual railway (geographical situation, climate, surface of line, gauge, timetables, rolling stock, etc., etc.); or, if it is not possible to ignore these characteristics, their influence must be ascertained and allowed for as accurately as possible in the statistical table.

It will be recognised that in practice it is almost impossible to solve the problem completely, but it would appear that quite satisfactory results might be obtained if all railways adopted the virtual ton-kilometre as the unit of consumption. This unit would, however, have to be clearly defined. It would in particular be necessary to define the following important points :

1° *Tonnage.* — Would the tonnage of the train be determined by the weight of the wagons only, or the weight of the wagons and locomotive combined?

2° *Passenger trains.* — What would be the method of fixing the weight hauled?

3° *Curves.* — On what formula would the resistance due to curves be calculated?

4° Down-grades and up-grades;

5° Stops, and slackening speed;

6° Speeds;

7° Timetables;

8° Heating of passenger trains;

9° Climate, winds, etc.

The problem is obviously very complicated, and even if all railways succeeded in allowing for all these elements and agreed as to the choice of identical formulæ, even this would not provide the means of an absolutely exact comparison. The choice of a given formulæ with regard to curves or gradients, for example, will not suit equally a railway in a mountainous district and another in flat country; the expenditure of energy in connection with stopping or slackening speed depends on numerous factors, and in particular on the longitudinal section of the line at the spot in question and the speed of the train; this energy may further be expressed in terms of different units; an exact determination of the speeds which should be observed to effect the total work of a given section of line is practically an impossibility; finally, elements of uncertainty exist as regards calculation of the expense of heating trains or of those items of expense which are dependent on climatic influences!

It is evident that it is necessary to be satisfied with an approximate solution of the problem, and that in defining the virtual ton-kilometre, only a very limited number of factors must be taken into account, and then only in accordance with simple and practical formulæ.

The information supplied by the various railways seems to indicate that the time has not yet arrived for making a final selection of the various elements which are to be taken as constituting the virtual ton-kilometre, or of the formulæ capable of embodying those elements. It is to be hoped, however, that all railways will adopt the suggestions put forward above, with a view to attaining some degree of uniformity. It may then be possible to endeavour to agree on the choice of a common unit of work.

The energy expended on haulage having been determined in as exact a manner as possible, the next step would be to calculate the corresponding consumption; and here again some standard unit would be essential. The calculation of consumption, in units of weight of fuel, has obviously no absolute value, since it depends to a large extent on the quality of the fuel used. The net cost is of still less value, at any rate so far as the possibility of comparison between different railways is concerned. The calorie might constitute a satisfactory standard unit. The calorific value of the fuel used having been determined, the statistical table would give, for each type of locomotive, or for each class of train (or for any other classification), the consumption per virtual ton-kilometre expressed in fuel calories.

As in the case of the virtual ton-kilometre, it appears premature to endeavour to fix definitely the method of determining calorific value. It would seem, however, that if statistics are to have any real significance, the lower limit of calorific power should be the unit chosen.

Finally, the statistics should include the net cost per calorie of fuel loaded on the tender.

CHAPTER II.

QUESTION *b*.

Grates. — The grates most widely used are fixed grates or rocking grates.

Fixed grates are made of cast iron or of sets of wrought iron firebars. The railways consulted use sometimes one type, sometimes the other, and sometimes both; but no railway has indicated a marked preference for any one type. If, on the other hand, the grates with sets of firebars have the advantage of lightness, solidity, and facility of manipulation, fixing and interchanging, they are easily displaced, their spacing may become irregular, and the efficiency of combustion may consequently suffer. On the other hand, the cast iron grates lend themselves more readily to an effective control of combustion, as the air space between the bars remains constant.

It does not seem necessary, however, to attempt to decide their relative merits, as the use of the rocking grate is becoming more and more general. The use of this type of grate makes it possible to run longer distances without cleaning the grate, and to use fuel of a quality which could not be used with the other type; it improves combustion and increases the boiler output; and, finally, it makes it possible to drop the fire immediately on returning to the engine shed, this being an important consideration from the point of view of maintenance of the firebox.

Certain railways complain of their high initial cost, the expense of keeping them in order, and the impossibility of keeping the space between the bars regular. These are real disadvantages, but they appear to be entirely outweighed by the advantages which this type of grate possesses.

Fireboxes. — The size of fireboxes, both in width and in height, and their overhanging or non-overhanging form, are characteristics which depend on the nature of the fuel used and the power to be developed. They are suggested or necessitated by the working conditions on the particular railway, and therefore it is not possible to speak of any particular tendency.

The same is not the case, however, if we consider fireboxes from the constructional point of view.

No railway has reported the existence (at any rate on any appreciable scale) of a new or special type of firebox. With the exception of fireboxes in which the crownsheet is supported by roof bars, which type is not very common, the great majority of fireboxes in use are Belpaire fireboxes or round topped direct stayed fireboxes.

In the case of the Belpaire firebox, the crownsheet and its staying are said to be most satisfactory; but this type has a great disadvantage in the complicated nature of its connection with the boiler barrel; further, the corners of the upper part of the box may come close to the gauge in the case of the larger types. In the latter case, the driver's view of the line may also be restricted.

The round topped firebox has the advantage of being more easily connected with the boiler barrel, and this form lends itself to the construction of wide fireboxes of large dimensions extending over the frames.

The Eastern Railway Company, the

Paris-Lyons-Mediterranean Company, the Paris-Orleans Company and the Tunisian Railway Company state a decided preference for the Belpaire firebox. The French State Railways are unable to state which type they consider most satisfactory. The Belgian State Railways use the round topped type only for the larger overhanging fireboxes. The other railways do not express any opinion as to the respective merits of the different types.

Copper is the metal generally used for the construction of fireboxes.

III. *Liquid fuel.* — None of the railways which have replied to the questions has made any extensive use of liquid fuel in locomotives. Where it has been used it has generally only been in a limited number of tests. In other cases it has only been used in special cases, *e. g.*, in shunting locomotives, or for passing through tunnels; sometimes also oil is only used as an auxiliary fuel, and in this case the tests carried out have been mixed combustion tests, *i. e.*, with solid and liquid fuel.

In spite of the very limited scope of such tests, one conclusion suggests itself very clearly, namely, that the question of net cost has always been the decisive factor in the abandonment of the use of fuel oil.

It is interesting in this connection to compare the various results obtained :

French State : 1 ton of mazout = 2 tons of coal.

Paris-Lyons-Mediterranean : 1 ton of mazout = 1.13 to 1.65 tons of coal.

Paris-Orleans : 1 ton of mazout = 1.7 tons of coal.

Swiss Federal : 1 ton of mazout = 1.54 tons of coal.

The above results only apply to the exclusive combustion of mazout, and not to mixed combustion. They can hardly be said to show any great uniformity, but they point to the conclusion that wherever trials have been made, coal had the advantage as regards net cost. The real net cost should also take into account provision for sinking fund charges, cost of upkeep, installation, transport, storage, distribution, upkeep of fireboxes, etc. As has just been remarked, the tests with fuel oil have been too limited to allow of a proper appreciation of these various elements.

The same applies to the value of the apparatus used, and the characteristics of the different kinds of oil.

However this may be, the advantages of the use of liquid fuel, as shewn by the replies received, may be summarised as follows :

1° Rapidity with which pressure can be raised in the boiler;

2° increase of the locomotive's evaporative capacity;

3° easier handling;

4° reduction of the work of the fireman, with the consequent possibility of attaining a higher output;

5° the liquid fuel lends itself to intermittent heating;

6° use of liquid fuel as an auxiliary fuel.

IV. *Pulverised fuel.* — Experiments in the use of pulverised fuel have been even less numerous and extensive than in the case of liquid fuel.

The Swedish State Railways have experimented with powdered peat on eighteen locomotives, subsequently replacing the powdered peat by powdered coal. The results were unfavourable, especially from the economic point of view.

The Italian State Railways have used powdered lignite on two locomotives, with the Fuller system. The tests were not very satisfactory.

The Dutch Railways have also tried the Fuller system for burning pulverised fuel on two locomotives, but are not yet in a position to publish the results.

Finally, the Swiss Federal Railways have tried powdered coal on one locomotive with unfavourable results. The failure is, however, ascribed to the fact that the coal used only contained from 12 to 14 % of volatile matter, whereas it should have contained at least 20 to 30 %.

The Federal Railways consider that this system might prove economically satisfactory if it were adopted on a sufficiently large scale, with adequate provision for preparation of the powdered coal.

As the preparation of the powdered coal necessitates the provision of special installations, it can only be done at a reasonable cost if these installations can be kept continuously occupied and give a sufficiently high output to pay off the capital outlay within a reasonable time. This is the problem which seems to have wrecked the efforts of the railways which have experimented with powdered fuel, and it is for this reason that we have not been able to arrive at an exact and correct opinion as to the numerous advantages which the use of pulverised fuel is generally held to possess, *viz.* :

1° possibility of using fuel of inferior quality;

2° increase of output in view of complete combustion and lower proportion of unburnt in the ash;

3° better superheating;

4° the air necessary for combustion not having to pass through a thick layer of solid fuel, the draught can be reduced, with a consequent reduction of the back pressure in the cylinders;

5° ease and rapidity with which steam can be got up;

6° greater elasticity of fire control; the quantity of fuel to be burned per unit of time can be regulated instantaneously as required, with consequent prevention of loss of steam through the safety valves during stops or on down gradients, which losses are usually remedied by undesirable opening of the firedoors;

7° reduction of the work of the fireman, with consequent possibility of developing higher power with only one fireman.

QUESTION *c*.

Mechanical stoking. — None of the railways consulted have made use of mechanical appliances for firing with the ordinary kinds of fuel, although mention may be made of the Java State Railways which have carried out one test, without however going any further.

QUESTION *d*.

Smoke consuming devices. — Some railways have used smoke consuming devices on a small scale *e. g.*, Belgian State Railways, Railways of Alsace-Lorraine, Java, Norwegian State Railways, Paris-Lyons-Mediterranean Railways and the Swiss Federal Railways. Only the latter and the Java State Railways consider them unreservedly successful. The other railways are less definite on the point, and the general conclusion seems to be that a result comparable to that obtained with a smoke consuming device can be attained by suitable manipulation of the blower and firedoor. This uncertainty as to the effectiveness of these devices undoubtedly arises from the difficulty of *measuring* the actual smoke consumption realised.

The essential point which emerges from the replies received seems, however, to be that the amount of smoke consumption realised by means of these special devices is not particularly apparent to the observer, whereas that is precisely what is desirable.

As regards the economy which smoke consuming devices may effect by improving combustion, this again is very questionable. Even those railways which approve the system have not been able to calculate its value from this point of view. It is, however, beyond doubt, as the Paris-Lyons-Mediterranean rightly remarks, that a smoke consuming device must improve combustion, and therefore must lead to a corresponding increase in boiler efficiency. But it is the same with these devices as with many other improvements intended to increase the efficiency of locomotives. The consumption tests with locomotives working under ordinary service conditions, whatever the care taken in carrying them out and measuring the results, are dependent on very numerous and important factors; and therefore the problematical nature of the results is not easy to compare with the advantages which are aimed at when any particular system is experimented with. Hence the lack of uniformity in the opinions expressed as to the value of such systems, the indecisive nature of the conclusions arrived at, and the often long and sterile discussions as to the advisability of introducing new systems. The question is one which can only be decided with certainty by means of tests with a stationary locomotive boiler.

As regards the smoke consuming devices, the tests so far carried out do not enable us to estimate their economic value and to compare this with the disadvantages and various forms of expense which their use entails.

Spark arresters. — These are in use on all railways. They are fixed in the smokebox, and are either horizontal or conical : in the latter case they are fixed between the exhaust pipe opening and the chimney base. Sometimes also the spark arrester takes the form of a cover on the top of the chimney. These various types are used either separately or together on locomotives which traverse districts in which there is a possibility of setting fire to adjoining property. The Damascus-Hamah Railways and Extensions even fit metal netting traps to the ashpans.

Spark arresters consist of perforated plates, of grates composed of bars, or of metal netting. The mesh varies from 4 mm. to 11 mm. (from 5/32 to 7/16 inch) according as the risk of fire is greater or less.

All the railways consulted declare themselves satisfied with the spark arresters in use, but none of them expresses an opinion as to the conditions which the apparatus should fulfil in order to reduce to a minimum the effect on the firebox draught. This question has, however, a double aspect, effecting both economy and power, which is by no means negligeable, and which, like a large number of the problems arising out of the present report, is worthy of being made the subject of careful tests on a stationary locomotive boiler.

It is no doubt due to this resistance to the passage of the gases that there is a tendency on the part of some drivers to take out their spark arresters. From this point of view, if the conical type of spark arrester is the lightest, most practical, and least expensive type, it is also, on the other hand, more easily removable by the driver, and this fact presents a certain danger.

Finally, spark arresters may, according to the type adopted, become more or less easily blocked up by cinders, especially when wet. This is a question which, from the point of view of economy and power, is of considerable importance, but on which the railways consulted have not expressed any opinion.

SUMMARY.

1. — Railways can be classified, according to the regulations which they adopt with regard to the fuel to be supplied to them, into two main categories :

The first category attach importance principally to the *source* from which the fuel is derived; the second lay down in addition numerous special conditions specifying as completely as possible the nature of the fuel to be supplied.

These conditions generally have to do with the size, percentage of volatile matter, percentage of ash, percentage of moisture, percentage of sulphur, fusibility of ash, friability, caking capacity, and, in the case of briquettes, the percentage of pitch and the degree of friability.

A further condition is sometimes added, *viz.*, the calorific value as ascertained by means of the bomb calorimeter; and, less frequently, the evaporative capacity is specified.

2. — It is essential to specify in the regulations, or in contracts for the supply of fuel, the procedure to be followed in the taking of samples, their preparation and their analysis. The results obtained by these operations depend on the methods adopted, and have therefore a value which is relative rather than absolute.

The fuel laboratory of a railway must be equipped in such a manner as to be in a position to ascertain completely whether the characteristics of the fuel supplied are in accordance with specification. It would appear desirable in addition to have one or more stationary locomotive boilers, which could be used for determining *beforehand* the characteristics of the kinds of fuel which are most suitable for the types of locomotive in use on the railway.

3. — It appears essential to submit the fuel purchased and delivered — apart from the laboratory or fixed boiler tests to which it is submitted as a matter of routine — to supplementary tests on locomotives working under ordinary service conditions.

4. — Certain railways purchase their fuel at a fixed price; others adopt a variable scale depending on the percentages of ash and moisture. In the latter case the penalties or premiums applied amount to from 1.5 to 2.5 % of the basic price of the fuel.

5. — The majority of the railways use mixtures of different classes of coal, these mixtures being made more or less methodically at the time of unloading in the fuel depots or when loading on to the tender. Certain railways use mechanical mixers. The latter plant appears to give a more even and reliable mixture.

Mixers may be installed at each of the engine sheds, and deliver the mixed fuel directly on to the tender; or they may be situated at selected centres, whence the mixed fuel is distributed to the various engine sheds in the vicinity.

6. — The size of stocks varies from railway to railway, but is not as a rule less than the equivalent of one month's consumption. Stocks increase to a maximum, representing the equivalent of several months' consumption, on the eve of periods of heavy traffic.

7. — Statistical tables relative to consumption, in the form in which they are at present prepared by railway companies, do not permit of comparison, the units adopted differing considerably.

A standardised form of statistics for

all railways would be of great value. It does not seem possible to achieve this immediately, but is it probable that a step would be made towards a satisfactory solution if railways would express their fuel consumption in calories on the basis of the virtual ton-kilometre. They should further calculate periodically the net cost per fuel calorie.

A more complete standardisation would necessitate a precise definition of the units and methods adopted for determining the calorific value and the virtual ton-kilometre.

8. — There is a marked tendency to substitute rocking grates for the ordinary fixed grates. They make it possible to run long distances without cleaning the grates, and increase the average firebox output.

9. — The great majority of fireboxes in use are either of the Belpaire type or of the round topped direct stayed type. Preference is generally given to the former of these two types. The latter type, however, appears more suitable, and even essential, in the case of boilers of large dimensions with fireboxes extending over the frames.

10. — Up to the present coal tar and mazout have only been used as fuel for experimental purposes. It follows from these experiments that under present conditions such liquid fuel cannot compete with solid fuel from the point of view of the net cost per kilogram of steam produced. The coefficient of value of mazout as compared with coal has been ascertained in the various experiments to lie between 1.13 and 2.

The conclusions are less clear as regards the result obtained with the use of liquid fuel in the particular case of very intermittent work (shunting locomotives) or in cases in which such fuel is used as an auxiliary fuel.

11. — The heating tests carried out with pulverised fuel (pulverised peat, lignite, or coal) have not been very extensive. The results were generally unfavourable. It appears, however, that in view of the difficulties inherent in the preparation of the pulverised fuel, experiments can only be decisive when carried out on a larger scale.

12. — None of the railways consulted uses mechanical stokers for ordinary solid fuel, except in certain exceptional circumstances on the Java railways.

13. — The effectiveness of smoke consuming devices, and the economy which they may represent, are not clearly established. Many railways show a tendency to abandon their use altogether.

14. — Spark arresters, horizontal or conical, fixed in the smokebox, consisting of perforated sheets, bargrates, or metallic netting, are used by all railways and give satisfaction.

[656 .253 & 656 .256.3]

REPORT No. 4

(**Italy, Belgium and Holland**)

ON THE QUESTION OF FIXED SIGNALS (SUBJECT IX FOR DISCUSSION AT THE TENTH SESSION OF THE INTERNATIONAL RAILWAY CONGRESS ASSOCIATION) (1),

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ENGINEER IN CHIEF OF PERMANENT WAY AND WORKS DEPARTMENT OF THE ITALIAN STATE RAILWAYS (2).

Figs. 1 to 38, **pp.** 1940 to 1995.

INTRODUCTION.

The question of signals is always a most important one, whether from the point of view of its great influence on railway working or from the point of view of the technical and financial problems that arise in the study of the problem and the necessity of improvement of existing signalling systems with a view to ensuring regularity and safety in working the traffic.

The increase in the traffic, the greater speed of the passenger trains, the increase in the speed of goods trains, the enlargement of the stations; the increased number of stations and halts, of junctions and of other special parts of the track calls for continuous improvement in the signalling system.

On the one hand the succession and complexity of the track appliances together with the variations in the speed of the trains arising from their presence are the cause of increasing complexity in the system of signals, the indication of which have to be increased in number, whilst, on the other hand, the increase in the speed of the trains demands simplification of the signalling system, and, within certain limits, to extend the zone to which the signals relate, so that the enginemen and guards may be able to interpret their meaning with ease and certainty in the short time during which they can be seen.

These conditions are, of course, rendered more difficult by atmospheric disturbances such as fog — dense, continuous, or intermittent — or by unexpected snowstorms, which limit the range of visibility and render the reading of the signals uncertain.

The problem becomes still more difficult in the case of lines which have varied gradients, such as occurs on mountain railways, or those on which there are a succession of curves of small radius and of tunnels which limit the range of visibility of the signals. In these cases it is necessary to adopt special methods.

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(1) This question is worded as follows : « Fixed signals. Principles of signalling for lines with dense traffic and for large stations. Form of day and night signals. Signal lights. Automatic block signals. »

(2) Translated from the French.

In our opinion, the signalling system should be studied as an exact science, proper account being taken of the technical and psychological aspects of the problem, taken at their correct values, and considered in detail so as to attain the desired result, due consideration being given to the economic aspect of the problem.

In describing briefly the signalling systems in use on the Belgian State, Dutch, and Italian railways, we are pleased to note the great improvements which have been effected with considerable success by these Administrations and to give an account of the methods adopted and the results obtained.

CHAPTER I.

Signalling system of the Belgian State Railways.

The history of the signalling system of the Belgian State Railways may be divided into three distinct periods; the first ended in 1900, the second comprised the period between 1900 and 1914, and the last began in 1918 after the war.

During the first period, protection of a danger point was secured by a disk or semaphore stop signal preceded by a distant signal.

The circular disk painted red and standing in a plane at right angles to the track, or showing a red light, gave stop; in its position parallel to the track or showing a white light, it gave line clear.

The semaphore, consisting of a rectangular arm, painted red, gave stop in its horizontal position or when showing a red light; inclined at 45° downwards or upwards, and showing a green light, it gave line clear, but speed to be reduced to 30 km. (18.6 miles) per hour.

The same signal that gives line clear to the main line without reduction of speed is fitted with an arm having a V-notch in the end; if this is inclined at 45° upwards or downwards (two green lights at night) it indicates that the road is clear for a train running at normal speed.

The distant signal with the rectangular face painted red and set at right angles to the track or showing a red light requires an immediate and absolute stop; in a position parallel to the track or showing a white light it gives line clear without slackening speed.

On double tracks the distant signal is always supplemented by audible (fog) signals.

To sum up : a danger point is protected by two absolute stop signals placed at a distance of about 700 m. (765 yards) from each other, the first being placed about 60 m. (65 yards) in advance of the danger point; in order that the stop can be made at the home signal it is necessary that the distant signal should show at a sufficient range of visibility to ensure that the signal is not overrun when at danger.

In the case where several signals succeed each other at short intervals, a stop semaphore serves as the distant signal to the following semaphore.

Junctions are protected in the same manner except that the semaphore has several arms which reading downwards control the running at normal or reduced speed from the main line to the left and to the right.

The block signals consist of semaphores having rectangular arms which give line clear without reduction of speed when inclined at 45° upwards (white light at night). They are not preceded by distant signals, but are supplemented with fog signals.

The system becomes somewhat complicated when applied to the protection of a large station, as it involves semaphores with several arms for controlling the roads giving access to the station over the different tracks or groups of tracks, and the departure semaphores with one or more arms controlling each departure track or group of departure tracks for the various routes.

In 1907 Mr. Weissenbruch (whose great work on railway improvement and particularly in signalling, commands our admiration, and whose early decease we deplore) then engineer-in-chief of the signalling department, devised a new signalling system based on English practice, but simplified and modified in such manner as to ensure the running of the trains at greater speed and with greater safety.

The two signals that were used to give stop, and to protect a danger point, were replaced by a stop semaphore placed about 100 m. (110 yards) in advance of the obstacle, and fitted with an arm which, when inclined at 45° upwards gave line clear; this was supplemented by a distant signal placed about 800 m. (half a mile) in rear, which could be run past when standing at danger.

The arm of the distant semaphore which was pointed at the end and painted yellow, when placed horizontally (yellow light at night) gave proceed with caution; and when inclined at 45° upwards (green light) showed that the home signal was at line clear.

The distant signal is preceded by five horizontal boards, known as « approach indicators », spaced 50 m. (55 yards) apart and standing approximately at 45° to the track. These boards are of wood whitewashed, or of plate enamelled white, each being 5 m. (16 ft. 5 in.) long, and from 30 to 40 cm. (12 inches to 1 ft. 4 in.) wide, fixed at a height of 1 m. 20 to 2 m. 40 (3 ft. 11 in. to 7 ft. 10 1/2 in.) above rail level so as to be sufficiently well lighted at night by the head lamps of the locomotives. Each set is numbered, by a series of oblique black bars, from one to five.

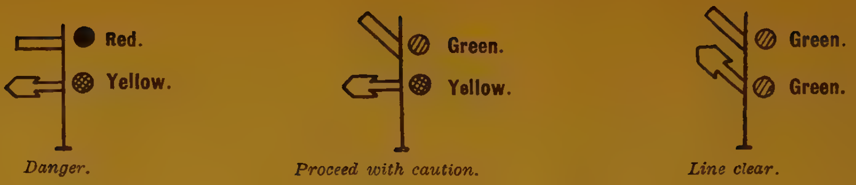
In order that the train service may be continued during fog at the same speed and with the same degree of safety as in clear weather, illuminated repeating indicators were arranged on the Brussels-Antwerp line in 1908 at a height of 2 m. (6 ft. 7 in.) above rail level, there were five of these, three being spaced 150 m. (165 yards) apart in rear of the stop signal, and two spaced also 150 m. apart in rear of the distant signal.

When two stop semaphores are less than 800 m. (half a mile) apart, the distant arm for the succeeding stop signal is carried on the preceding semaphore post and is placed below the stop arm.

The two arms, stop and distant, may show the combinations shown in figure 1.

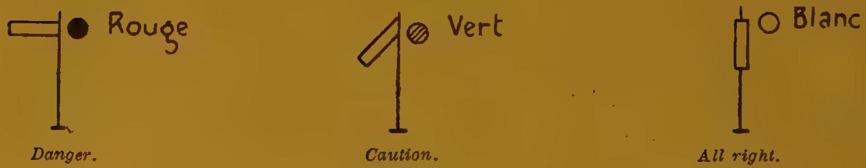
At junctions and in stations protection is assured by stop semaphore arms and danger arms carried on posts of multiple bracket pattern, of which the doll posts from left to right protect the different groups of tracks.

The various tracks in a group are denoted in some cases by numbers reproduced on the arms referring to those tracks. Direct entrance to a siding is protected by a stop arm bearing a ring,



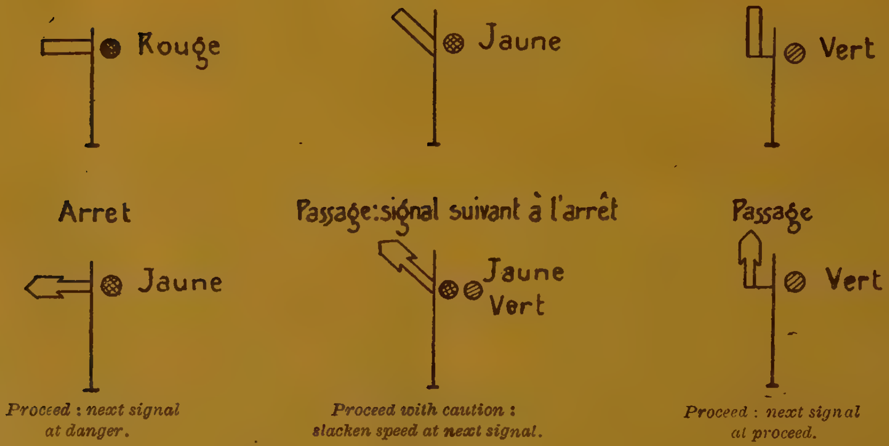
Danger. *Proceed with caution.* *Line clear.*

Fig. 1.



Danger. *Caution.* *All right.*

Fig. 2.



Proceed : next signal at danger.

Proceed with caution : slacken speed at next signal.

Proceed : next signal at proceed.

Fig. 3.

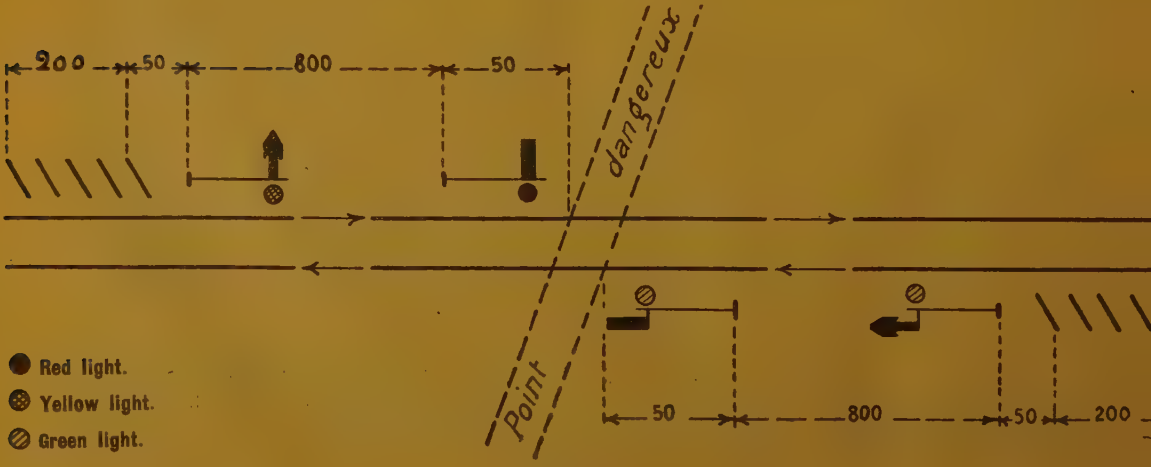


Fig. 4.

Translation of French terms : Rouge = Red. — Vert = Green. — Blanc = White. — Jaune = Yellow. — Arrêt = Danger. — Passage ; si suivant à l'arrêt = Proceed ; next signal at danger. — Passage = Line clear. — Point dangereux = Danger point.

but not supplemented by a separate distant signal.

The block signals are the same as those that we have described above; in stations the block signal serves as the departure signal.

The progress that has been made in increased speed and safety by the use of this system, in place of that which preceded it, is obvious.

It is only in the case of large stations that the application of this method has involved a complex semaphore system with one or more kinds of arms carried on multiple bracket posts to protect the arrival and departure groups of tracks.

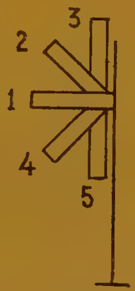
Mr. Weissenbruch, the chief engineer, proposed in 1918 the adoption of the three-position semaphore arm, in use on the American railways, which enables the very usual combination of stop and distant arms to be simplified; this combination is very common where the block sections are of short length.

It was in fact only a return, with suitable improvements, to the signal that the representatives of the English Companies had proposed to adopt at the Birmingham conference in 1840, a signal that gave the indications shown in figure 2 (1). The employment of this signal in Belgium was abandoned not only on account of the adverse view taken by the locomotive-drivers' Society, but also as the result of the construction of signal cabins with interlocking frames at junctions, and the general introduction of the absolute block system, which in some cases obviated the necessity for requiring reduction of speed.

By the elimination of the vertical position for the arm with the post, the semaphore could occupy two positions, *danger and line clear* : the white light having been abolished as it might easily be mistaken for other lights or shown in the event of breakage of the coloured spectacle glasses. This simplified the mechanical operating of the semaphore by means of a single wire.

In the new signalling system, the home and distant signals can take the positions shown in figure 3.

Of the five positions that the semaphore arm could occupy relatively to the post, only those of the upper quadrant have been retained, in order that in the event of damage, the arm having an upward inclination at 45° or 90° to the horizontal will fall by the action of gravity to the danger position; and this necessarily involves the operation of the arm successively to the caution and line-clear positions.



The arm of the home signal is of elongated rectangular shape, having the face painted red with a transverse white stripe.

The horizontal position of a home signal arm (showing a red light at night) requires a stop to be made; the inclined position (yellow light at night) allows the train to proceed, but shows that the next home signal is at danger; the vertical position (green light at night) allows running past at normal speed.

Contrary to the old practice, the light is now shown on the right hand side of the post.

The arm of a distant signal is arrow

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(1) The first railway semaphore was erected at New Cross, London, in 1841.

shaped, terminating in a point, and has the face painted yellow with two arrow shaped black lines.

In the horizontal position, the arm of a distant signal (yellow light) allows the driver to proceed, but it shows that the home signal to which it relates is at danger; the inclined position at 45° (two lights, yellow and green) indicates attention to the driver and that he is approaching a point requiring reduction of speed; the vertical position (green light) allows running past at normal speed.

For the protection of the various danger or speed restricted points on the line, the home and distant signals may, according to the conditions, occupy two or three of these positions.

The semaphore posts are painted white. The arms and the operating gear for the new signalling system have been fitted either on the old steel posts or on new posts of reinforced concrete.

When the arm can not be read easily in the danger position, a screen painted white is arranged behind the signal.

On all lines not yet fitted with the new signalling system, the arm is raised to 45° from the horizontal to indicate line clear. In order that the drivers may be able to recognize that these signals are of the old type, and in order to avoid risk of confusion with the new signals, in which the arm stands in a vertical position for line clear, the ends of the arms of signals of the old type are fitted with a circle of sheet iron.

The protection of a simple danger point, the commencement of a block section, a busy level crossing, a swing bridge, or a halt, is shown in figure 4.

The distances given in figure 4 between the signals and the danger point are those generally adopted on level lines, or those having a gradient not exceeding 5 per mil (1 in 200) up or down.

These distances are increased respectively by an amount of 20 m. (65 ft. 7 in.) per 1 per mil increase of up or down grade, due account of course being taken of other local conditions such as curves, level crossings, etc., in such manner as to ensure that the distant signal may be visible at a distance of at least 300 m. (330 yards).

If the range of visibility of the distant signal is less than 300 m. it may be repeated by a second signal suitably placed.

All the distant signals are preceded by a set of five white horizontal boards, an arrangement that has been found satisfactory even in dense fog. These are supplemented during fog and snow, at specially dangerous points, by Duplex type fog-signals consisting of two small boxes filled with explosive. In the figure to which reference has just been made, and in subsequent figures, the arrangements usually adopted are shown according to the conditions existing at the point to be protected.

When two home semaphores follow each other at less than 1 km. (1 100 yards), the distant signal is omitted for the further signal, and the nearer serves as a distant signal for the signal that is further away.

In figure 5, are shown the various positions that the home signal arms may occupy when protecting two block sections that follow closely on each other.

As a general rule, the block sections are 2 km. to 3 km. (1.25 to 1.85 miles) in length.

In the cases in which the distances between the two home signals are less than 800 m. (880 yards), the first (nearer) distant signal, of the three-position type, repeats the positions of the two home signals.

At junctions, in order to simplify the

system, in place of the bracket signals, which reproduce the position of the home signals and carry two or more arms, a distant signal is used of the three-position type; when inclined at 45° it shows that one of the arms relating to the branch roads is at line clear, and when it is in the vertical position the main line is clear.

In figures 6 and 7 which follow, are shown the positions which the arms of the home signals may occupy respectively for protecting a single junction, or two junctions following each other at a short distance.

In more complicated cases of danger points following on each other, for instance block posts at distances of less than 1 km. (1 100 yards) in advance of a junction, or junctions following each other at less than 800 m. (880 yards) the bracket signals may be repeated by means of the distant signal just described. Though the arrangement of the signals is more complicated, they are always easy to read. Regarding signalling in stations, it should be added that the home signal arrangement protecting the entrance to groups of tracks is either of the bracket or bridge type, or of the multiple bracket type with arms at various heights that enable the through road signals to be distinguished from the others; when all the arms are at the same height all roads may be run over at the same speed.

If the speed is less than 40 km. (24.8 miles) an hour, the bracket type of home signal may be replaced by a single-arm signal combined with a route indicator showing (by numbers or letters) which route is clear.

The arm that protects the entrance to a siding or to shunting points is fitted with a ring painted black. For large stations, the indication of the route may be given by means of arms on a multiple bracket post carrying one or more arms bearing numbers.

In very large stations, the limit of the route may be shown by a semaphore arm differing from the ordinary type in having a vertical bar painted black in the middle of the arm.

For departure from auxiliary tracks and particularly from goods roads, red disks are used occupying two positions: at right angles to the track (red light) requiring a stop to be made, and parallel to the track (green light) giving road clear.

Shunting operations are controlled by means of arms of smaller size, painted red and capable of occupying three positions: horizontal (violet light) — stop; inclined (yellow light) — limited operations; vertical (green light) — long operations or dealing with a whole train.

The violet glass should be of such shade that with any coloured flame, or under any atmospheric conditions it gives a light that approaches red rather than blue.

When shunting operations are carried out on tracks over which trains may be run, small arms for controlling these operations are arranged below the main arms that control the movements of trains.

Figure 8 for example shows the signalling system adopted at an intermediate station having a through side track.

Given the service that has to be carried out in the station, and applying to it the rules that we have given, it is easy to determine the positions that the various signal arms must occupy. If the station is on a line worked on the block system, the station is a block post and A, A′, and B are both departure and block signals.

The principle is that a train standing on one of the main tracks in the station occupies a block section and prevents a train from being allowed to enter the preceding section. In cases, however, where a train has to stand for a long time in a station (say 10 minutes) for shunting operations or putting off stock by setting back, and where the intensity of the traffic requires it, a separate block section is made between the home and departure signals. Figure 9 shows the signalling system adopted for a large main-line station.

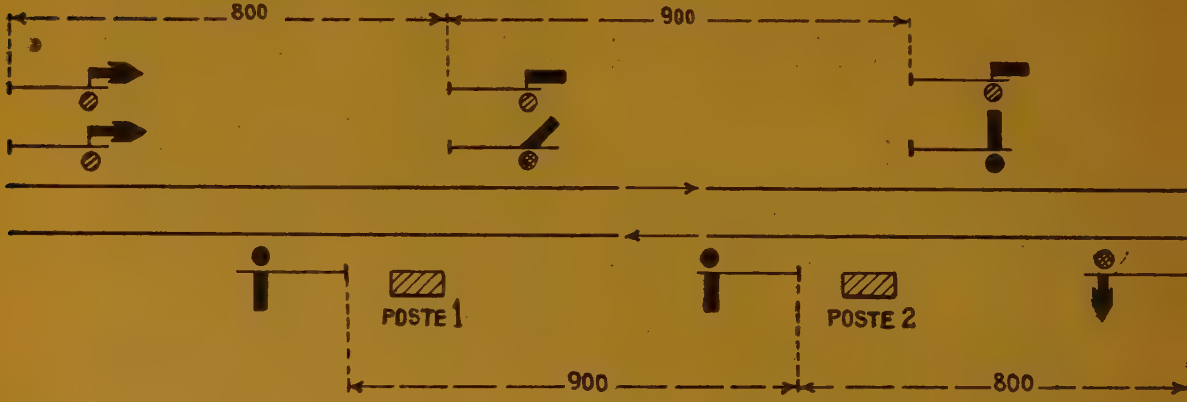


Fig. 5.

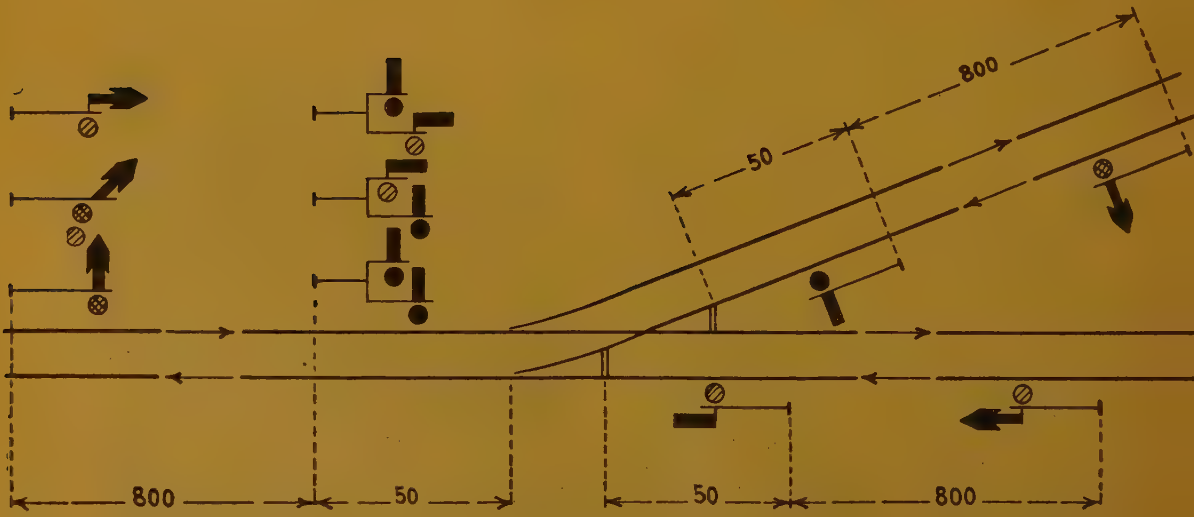


Fig. 6.

In the large main-line stations, the cabins from which the successive points and signals are operated serve as block posts, either by interlocked apparatus or by telephone; in the latter case the block section between the cabins is supple-

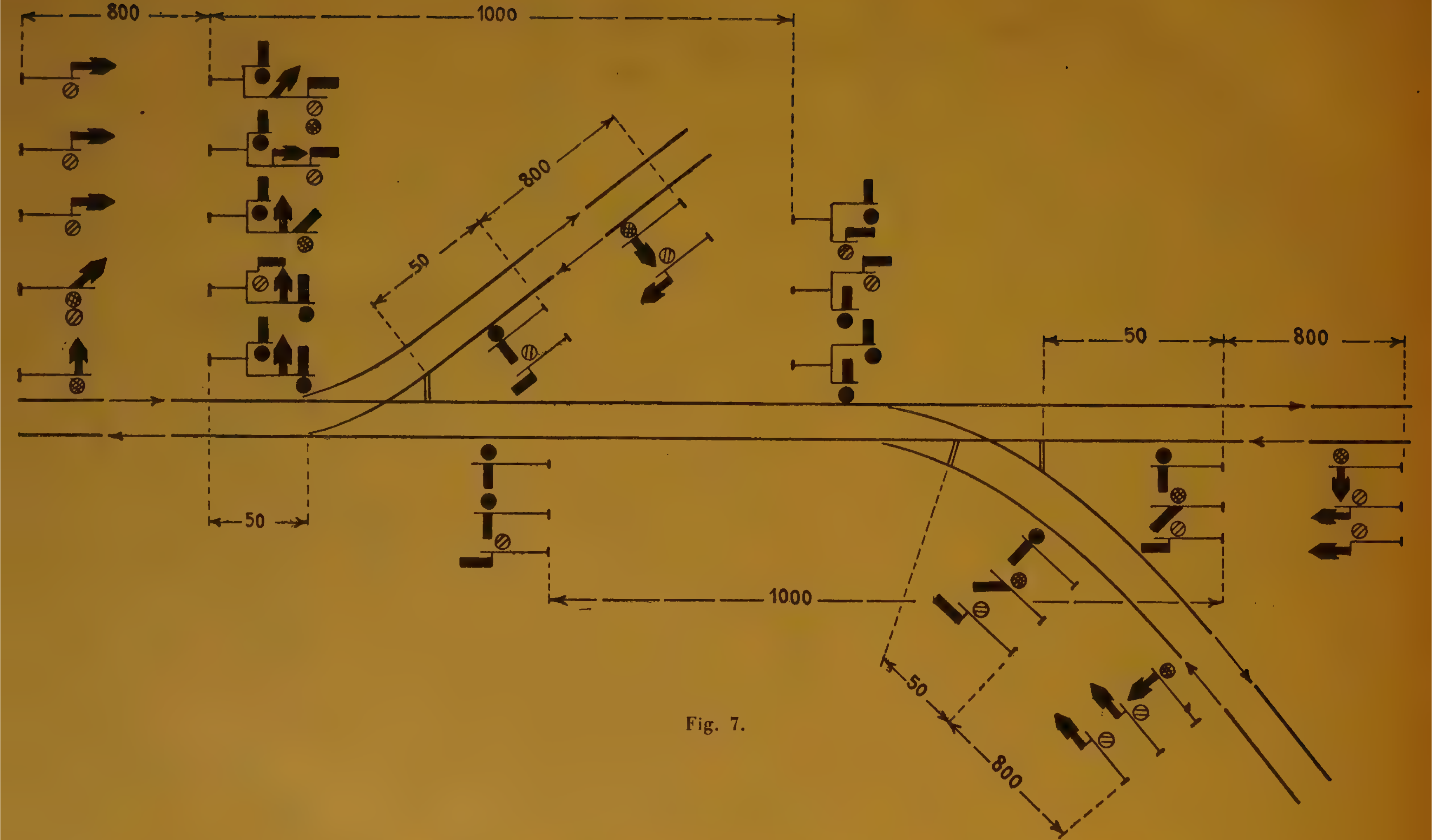


Fig. 7.

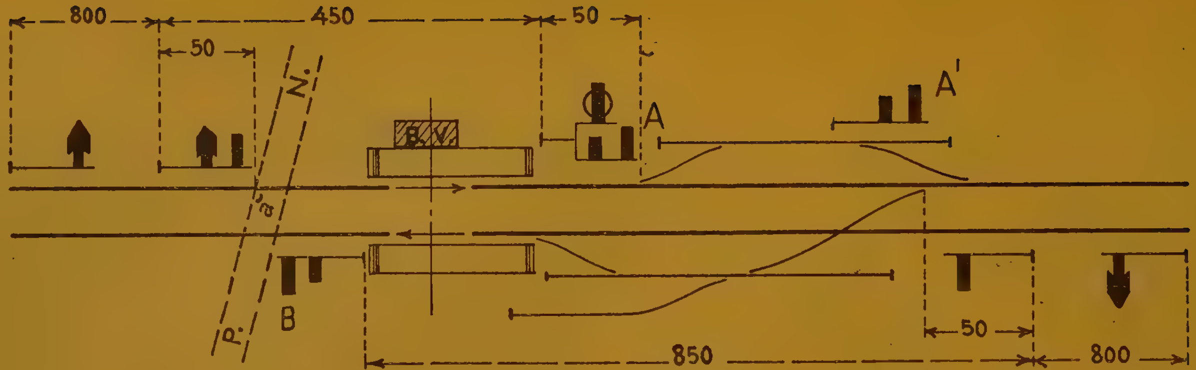


Fig. 8.

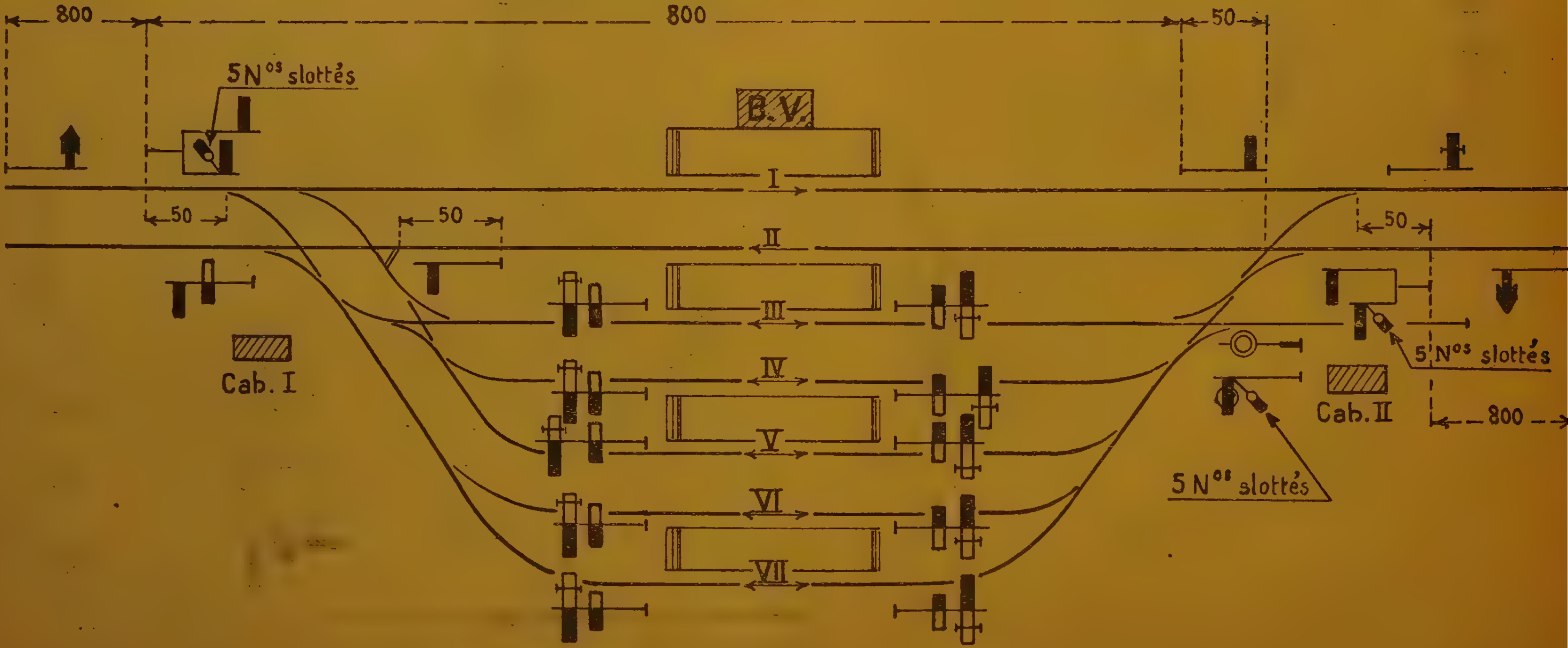


Fig. 9.

Translation of French terms: 5 N^os slottés = 5 slotted number arms.

mented by slotting the signals from the two cabins. The slot levers and route levers are interlocked. The block posts accepting the trains for the station can operate the signals for admitting the trains to the station without the necessary intervention of the stationmaster.

Local instructions relating to each installation give the road on which each train is to be received, and the only cases, in which the intervention of the stationmaster is required, are those in which the local instructions are not followed exactly.

With a view to avoiding the receiving of a train on a road that is already occupied, track circuits are fitted, particularly in those installations that are entirely electrically operated.

For the lighting of the signals, the Belgian State Railways generally use paraffin oil lamps with glass chimneys, of the E. B. type, and paraffin lamps without chimneys of the Burton type.

The Burton type of lamp uses 135 gr. (76.14 drams) of paraffin per day of 24 hours. The maximum time the lamps burn without filling or cleaning is 24 hours. The lamps are fitted with reflectors of German silver. The lamps showing one or two lights are fitted with lenses 150 mm. (6 inches) in diameter. The second light of the two light signals is given by a mirror placed at 45° to the line of sight of the driver.

In order that the signalman may be warned in case of a lamp going out, the lamps are fitted with backlights.

Electric lighting of signal lamps is provided in those stations in which the points and signals are operated electrically, and at some stations and places on the line where there is a duplicate electric supply. In these cases, special lamps are used with special flexible suspension. In order to allow of disconnecting and taking the lamp down for maintenance purposes, flexible connections with plugs are used. The lamp is not lowered by mechanical means.

Each light shown by the signal is obtained by means of a single lamp. The lamps are of 16-candle power and are of the metallic filament type (0.2 amp.) or with carbon filament (120 to 130 volts and 0.5 amp.).

The lighting is controlled from a board with galvanoscopes (indicators). If a lamp goes out the corresponding indicator is no longer excited and rings a bell in the signal cabin.

In Belgium, coloured lamps are not used, nor are there signals lighted by transparency at night, nor are there any flashing lights, nor signal arms lighted at night by reflectors.

CHAPTER II.

The signalling system of Holland.

The signal system of the Dutch railways, consisting mainly of the two large railway systems — the Netherlands State Railways and the Dutch Railways, — is still under rules and regulations that date from 1875.

A danger point is protected by a home signal preceded by a distant signal, and at a fixed distance of 850 m. (930 yards), by a fixed indicator (known as Baak) shown in figure 10.

The semaphores have their arms at the

height of 9 m. (29 ft. 6 in.) above the rail level.

The home signal arm, painted red, is of rectangular form terminating in a sector of a circle, and stands on the right of the post. In the horizontal position (red light at night) it reads immediate and absolute stop. In the position inclined at 45° upwards (white light at night) it reads road clear without reducing speed.

The arm of the distant signal, painted red, is of rectangular form with the end cut square; inclined at 45° down (green light) it shows that the home signal which it precedes is at danger. It therefore reads reduce speed; inclined at 45° upwards (white light) it shows that the home signal to which it relates is at line clear.

Regarding the use of a white light for showing line clear, the Netherlands railways state that the white light shown by a paraffin lamp fitted with a reflector can be sufficiently easily distinguished from the other lights that are seen on railways, by its intensity and by its slightly yellow colour.

Trials have nevertheless been made with the yellow light, but this has not been found satisfactory, as the colour under some special circumstances is liable to be confused with red; or, when of a lighter shade, is not definitely distinguished from white. For the back lights indicating the arm positions, nevertheless, the colours : yellow (arm at danger) and blue (arm at the line clear) are used.

The distant signal must be visible at a distance of 850 m. (930 yards).

The three positions of the arm of these semaphores : inclined upwards — line clear; inclined downwards — reduce speed; and horizontal — stop, differ considerably from each other, and consequently give absolutely definite readings. From the constructional point of view, they have the advantage that in the event

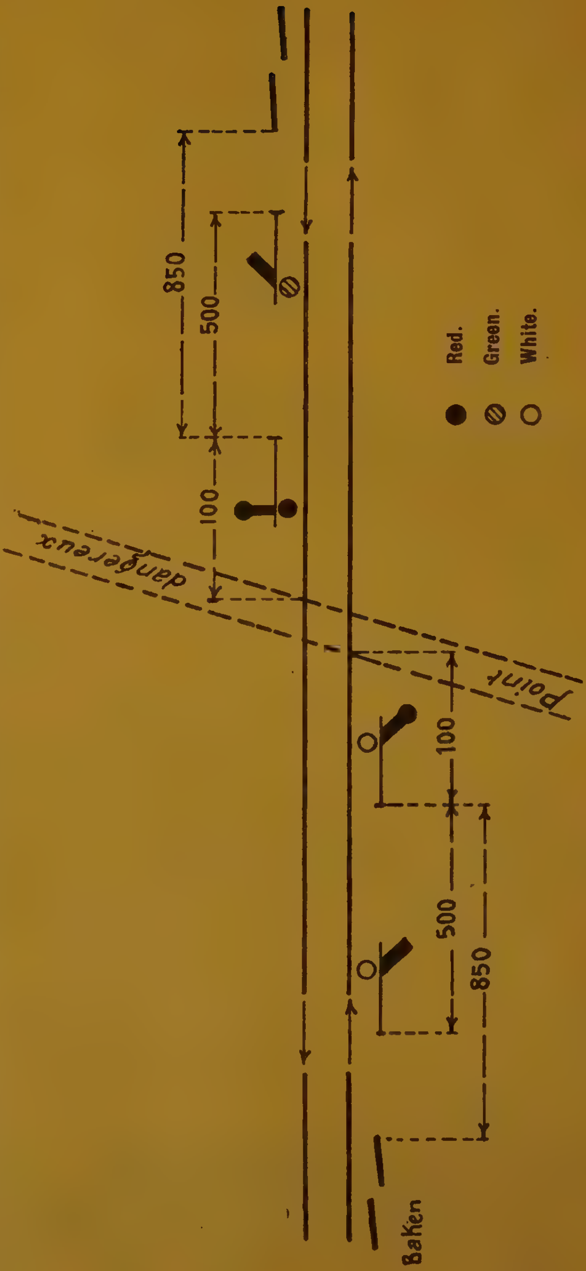


Fig. 10.

Translation of Foreign terms Baken = Boards. — Point dangereux = Danger point.

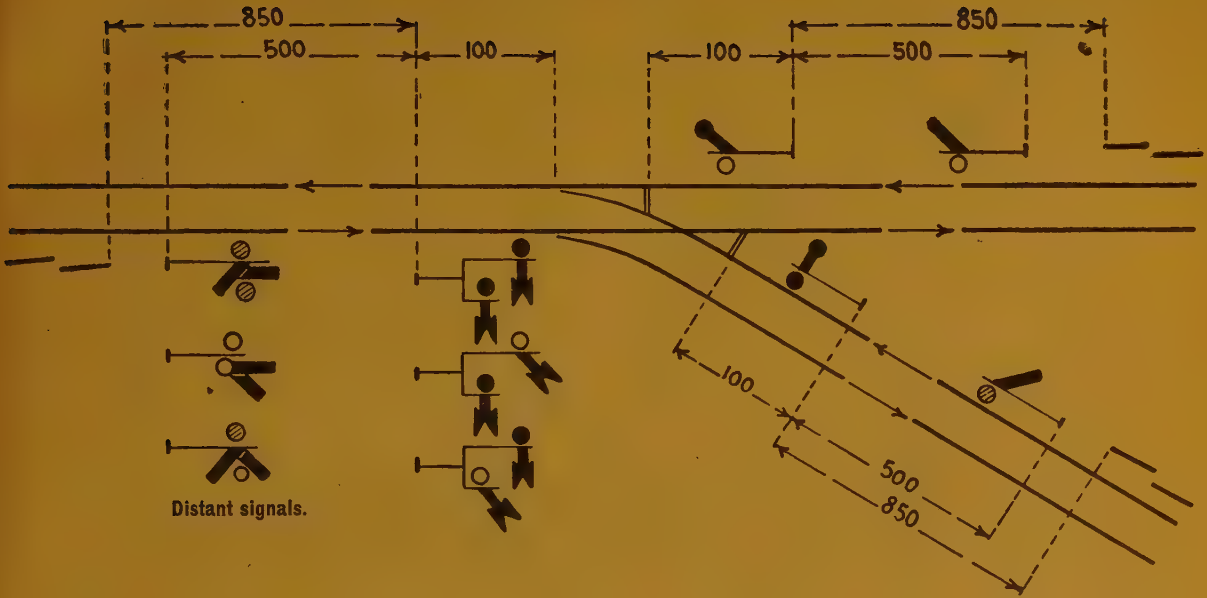

Distant signals.

Fig. 11.

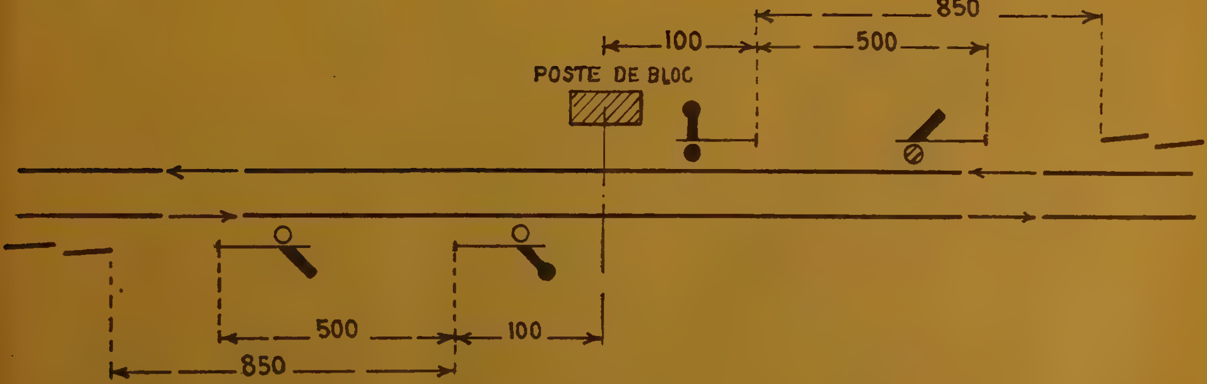

POSTE DE BLOC

Fig. 12.

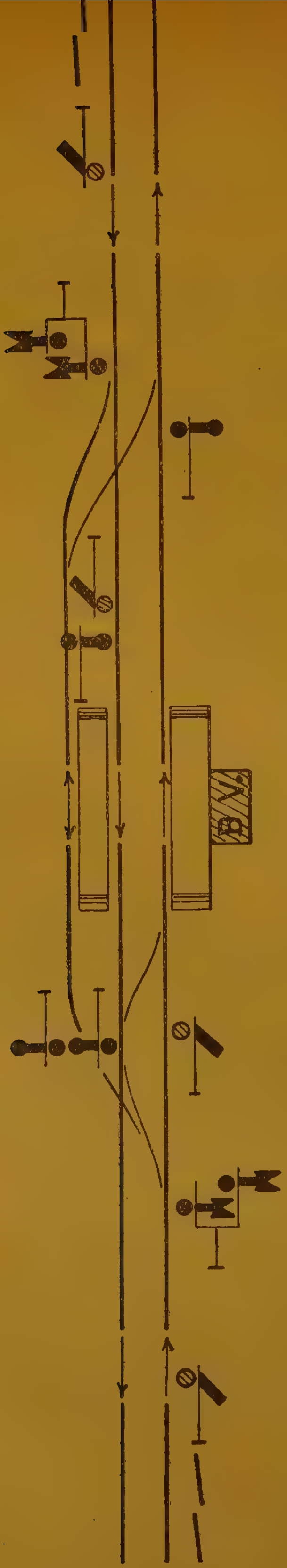


Fig. 13.

of breakage of the wire, the weight of the arm restores the signal to danger or to reduce speed respectively.

In the case in which the visibility of the arms is not sufficient, these are painted in two colours, red and white; or the arm shows against a screen of white wood.

Approach to these semaphores is indicated by a group of two or three horizontal boards about 5 m. (16 ft. 5 in.) in length, arranged at a slight inclination to the line of the track, and at a distance of 10 m. (32 ft. 10 in.) from each other, and at a height that increases from 1 m. 50 to 3 m. (4 ft. 11 in. to 9 ft. 10 in.). These boards are rendered sufficiently visible, even in fog, by the light they receive from the headlights of the locomotives.

At particularly dangerous points, moreover, such as an open bridge or a junction where a train is standing, fog signals are used to supplement the home signals at danger.

In order to reduce the consumption of fog signals in foggy weather, it is preferred to repeat the distant signal by another of the same shape in accordance with a special regulation. Trials made of cab signals on the locomotives have not given good results.

Junctions are protected by bracket semaphores, the arms of which are arranged according to the geographical order of the tracks from left to right, although the traffic runs on the right.

In figure 11, the arm relating to the main line, allowing a speed exceeding 45 km. (28 miles) per hour, is arranged higher than the arm that relates to the branch road, which requires speed to be reduced to 45 km. per hour.

The distant signal that corresponds to a junction signal consists of a group of two arms, which can occupy the three positions reading respectively as home signal at danger (two green lights), main line clear (two white lights), and branch line clear (one white and one green light).

The combination of two lights is obtained from one lamp by means of a mirror; in the case of a lamp going out, both coloured lights fail to show, and there is no risk of giving a wrong signal.

In some cases, reduction of speed to 30, 45 or 60 km. (18.6, 28 or 37 miles) per hour is shown by visible indicators of diamond shape.

All double-track lines carrying express traffic are worked on the Siemens and Halske block system. The length of the block sections depends on the amount of traffic; the shortest sections have a length of 1 200 m. (1 320 yards). As can be seen in figure 12, a block post on the main line comprises the signals that have already been described.

A station on a line worked on the block system is protected by a system of signals such as is shown in figure 13.

The portion of the main line between the successive block and protecting signals forms a block section. In large stations, the same signals are used for both interlocking and block purposes.

The same forms of semaphore arms are used for giving access to and departure from the various tracks. These signals are sometimes carried on signal-bridges.

The arm protecting a main track is arranged at a height above the others.

The secondary signals relating to the station are quite different and are such as : the disk signal(red and white lights) which indicates closing and opening of level crossing gates; the track-stop with its small disk (white with a red stripe), which protects access to a track; the fishtail signal, which in its horizontal position (violet light) forbids shunting, and in its vertical position (white light) allows shunting over a definite route; the signal with a white arm and two black vertical stripes allows shunting over a section; the signal with a white arm and two crossed stripes forbids shunting on this same section; small discs of various shapes at points, etc.

Many of these shunting signals are lighted by transparency.

Paraffin oil is generally used for the various signal lamps. For many of the

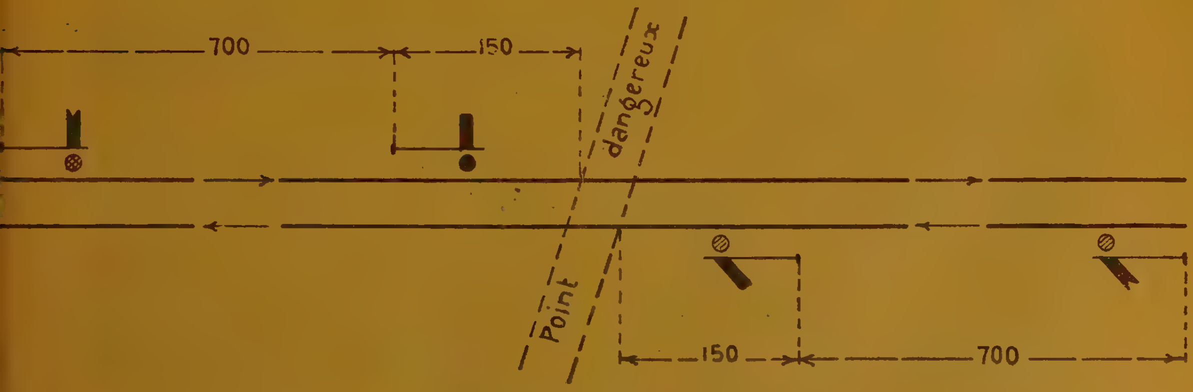


Fig. 14.

Translation of French terms : Point dangereux = Danger point.

local signals electric lighting is used.

A paraffin lamp uses 1 litre (1.76 pints) per 42 hours. The lamps are filled and cleaned every day.

The lamps are fitted with reflectors of nickel-plated copper. Some distant signals are fitted with flashing lights on the « Aga » system.

The Netherlands railways have made trials of light signals, but are not yet in a position to give a decisive opinion on them.

The pointsmen's frames, arranged at different places in a large station, have, on the main lines, the same function as block posts if the distance between these points is sufficient, that is to say, more than 1 000 m. (1 100 yards). In general, these posts, when at a distance of less than 1 000 m. are subsidiary to a central post situated inside the station.

The signals for admitting trains to the various tracks in the station cannot be operated from the pointsmen's posts except by order of the stationmaster.

Track-circuits arranged so that the home signals relating to any particular track can only be set to line clear when the track is actually clear, have not been generally adopted in Holland.

CHAPTER III.

The signalling system of Italy.

On the main lines on which the « giunto » or « consenso » telegraphic block system or absolute block system is in use for protecting a danger point (a station, a halt, an important level crossing, a tramway crossing, etc.) « double signalling » has been adopted, consisting of a home signal (also known as a first class signal) preceded by a distant signal, as shown in figure 14.

The fixed signals, both on single tracks and double tracks, are generally placed on the left of the track with regard to the direction of the traffic.

By day, the arm of the first-class signal in its horizontal position (red light) requires an absolute stop of the train without passing the signal.

The arm inclined downwards at 45° or 54° (according to the type of signal) (green light at night) gives line clear.

The arm is of rectangular form, painted red with a white vertical stripe on the face. The arm of the distant signal has a notched end, and is painted yellow with a vertical white stripe on the face.

In its horizontal position (yellow light at night) it shows that the following signal is at danger and requires the driver to reduce speed so as to be able to stop without passing the home signal.

When the arm is inclined downwards at 45° or 54° (green light at night) it gives line clear.

The back of the signal arms is painted white with a black vertical stripe, and shows a green or white back light called « spia » according to whether the arm is in the horizontal or inclined position respectively.

In tunnels, the home and distant signals are replaced by disks with a fixed lamp and a moving spectacle plate with two colours, red and green, or yellow and green respectively.

The indications of the signals operated by a single wire, are repeated at the pointsman's post (or signal cabin) by electric apparatus with discs coloured white and red, giving three readings : signal « on » (red indicator), signal « off » (white indicator), signal doubtful (white and red indicator).

The distance between the home signal and its distant signal is either about 400, 700 or 1 000 m. (440, 770 or 1 100 yards) according to whether the up or down gradient is more than 1 per mil *up* in advance of the signals for the shortest length; between 10 per mil *up* and 3 per mil *down* for the medium length; or more than 3 per mil *down* for the longest length.

The distance of the home signal from the point that it protects must be at least 100 m. (110 yards); as a general rule, it is 150 m. (165 yards).

The home and distant signals must be visible at a distance of at least 100 m.

In case of fog, thick snow, or other atmospheric disturbances, which reduce the visibility of the signals, the distant signal when at danger is supplemented by a group of three fog signals placed 25 m. (27 yards) apart, and the first placed 100 m. (110 yards) in rear of the signals. The fog signals consist of small sheet metal boxes filled with fulminating material and fitted with two clips for enabling them to be fixed to the head of the rail. The placing of fog signals direct by hand may be replaced by the use of apparatus for putting the fog signals into place.

The « mettipetardi » consists of a container with two cylindrical parts, in which the fog signals are arranged in columns.

At the bottom of the container a large iron plate containing two grooves slides, and when it is pushed out towards the rail, it carries two fog signals under the fog signal device on which the first wheel of the train acts. Generally, two « mettipetardi » are used at a distance from each other of 25 m. (27 yards) and are operated by the same transmission gear.

In the tunnels, the fog signals are replaced by a detonating alarm apparatus of the percussion type (« Scartazzi-Opezzi »), arranged in a manhole at nearly 100 m. (110 yards) from the distant signal and interlocked with it in such manner that when the signal is set at danger, a treadle fixed near the rail and sightly raised, when depressed by the first wheel of the train, acts on suitable mechanism, and causes the simultaneous discharge of two of the 48 cartridges contained in the cylinder.

In tunnels in which there are difficulties in visibility on account of smoke that does not clear away entirely, the distant signals are preceded by audible warning signals, giving an indication of their position, and consisting of a steel plate (gong) struck by a hammer actuated by a treadle on which the wheels of the train act. Trials made with a view to adopting the acoustic warning (gong) in the open air, have not given good results, either because the driver cannot always hear the sound, particularly in unfavourable atmospheric conditions, or on account of the annoyance caused to the neighbouring inhabitants.

In order to avoid the heavy expenditure on placing fog signals by hand, and of the material that has to be provided for the fog signal service, it has been proposed to try approach indicators, for the distant signals, on some of the lines in northern Italy which are subject to fog for several months of the year. It is intended to use white horizontal boards, and trial of these has been encouraged by the success which this system has had on the Belgian State Railways.

The experiment was commenced two years ago on the Milan-Piacenza and Milan-Brescia lines.

Groups of five parallel boards were used, the boards being inclined at 45° to the direction of the track.

During the last two winters, these lines have not suffered from the usual intense fogs of long duration, but it has been possible to prove that the boards can always be seen well when the locomotives are fitted with electric head lamps instead of the ordinary paraffin lamps, and when the driver stands on the left of his locomotive. As the greater number of locomotives are arranged for the driver to stand on the right, a section of the Milan-Piacenza line was arranged with a second group of boards placed on the right outside the track and opposite to those on the left.

The trial will be continued during this winter, and if, as it is expected, it gives favourable results, its application will be extended, a begining being made on those lines that suffer from light fog and gradually carried on to those that have thick but not continuous fog, in order that the crews of the locomotives may become accustomed to these new indicators instead of the fog signals that had been in use for many years, and had been found satisfactory by the locomotive and train crews.

On lines equipped for electric traction, the eight Mannesmann tube supports carrying the line contact, that precede the home and distant signals (which are carried on brackets from the post in order to render them more visible), are alternately painted with helical black and white stripes and with horizontal black and white stripes.

On light-railways and main lines, on which a double signalling system has not yet been installed, the protection of a danger point, a station, a halt, etc., is effected by a single signal, either a disk or a semaphore (second-class signal), the arm or visible portion of which bears the figure 2, in order to distinguish this signal from those of the first class.

By day, the horizontal arm over the visible disk standing at right angles to the track (red light at night), requires the train to stop if possible before passing the following signal, and afterwards that the train shall proceed with caution until the rear of the train is alongside the signal.

The inclined arm, or the disk arranged parallel to the track (green light at night; sometimes white in the case of disks) gives line clear.

The range of visibility of a second-class signal should be 700, 1 100 and 1 300 m. (770, 1 200 or 1 430 yards) according to the gradient of the line on the section immediately in advance of the signal; the minimum when it is more than 10 per mil *up* grade, the medium distance when it is between 10 per mil *up* grade and 3 per mil *down* grade, and the maximum when it is more than 3 per mil *down* grade.

When a signal of the second class has not the required range of visibility, it is preceded by a fixed signal for slackening speed consisting of an indicator painted green and showing a green light at night.

At junctions and in stations having several groups of tracks, the various arms of the home signals are either arranged vertically on the same posts, or more frequently are arranged in order horizontally on a multiple bracket post.

According to the position from top downwards or from left to right respectively, they control the trains running on to various tracks or on to the various groups of tracks arranged from left to right. On the bracket posts, one of the arms may be arranged at a greater height than the others when it is required to show that an arm protects the entrance to the main line, and when at the entrance to a station having one or more groups of goods tracks and one passenger track only, it is required to distinguish the signal arm protecting the passenger track.

The home signals with several arms are preceded by a distant signal having a single arm.

In tunnels, the semaphore with several arms is replaced by lantern disks similar to those already described, arranged vertically.

Figure 15 shows the method of protecting a junction.

The Cardani-Servettaz electro-mechanical block system is that generally in use; it has electric block instruments interlocked with slotted signals; this system comprises the clearing of a block section, and the occupation of a block section (setting the protecting signal to danger), effected automatically by the last axle of the train, by means of contacts called respectively the « line clear » and « train on line » contacts, which are operated by the deflection of the rail when the vehicles pass over it. These contacts are supplemented or replaced by insulated lengths of rail.

The signal arrangements of a block post on the open track are shown diagrammatically in figure 16.

When two signal cabins are in one station, or are separated by only a short distance, as a method of simplification, the distant signal arm of the following home signal is combined with the home signal preceding this, as shown in figure 17.

The semaphore with combined arms may show the three positions given in figure 18 for the common State Railways' type, and those shown in figure 19 those of the type used in upper Italy (now obsolete).

The backs of these semaphore arms are painted white with a vertical black stripe, and at night show a green, a violet, or a white light according to whether the first-class arm is horizontal or both arms are at line clear.

Figure 20 represents a small station with a backing-down lie-by siding arranged on a line worked on the block system.

The signals A and B, of which A′, and B′, are respectively the distant signals, are both departure and block signals. The arms of the distant signals A′ and B′ are combined with those of the first class for the protection of the station.

The sections comprised between the departure signal and the preceding protection signal form internal block sections for the main tracks in this station.

Shunting operations are controlled from the stations by means of low signals (ground signals), having two rectangular or circular faces arranged at right angles to each other, the one painted red and the other green, which, at night, correspond to red and green lights.

The ground signals protect the various shunting operations either long or short, and are interlocked with the points of the corresponding routes.

The red face or red light requires a stop, the green face or green light gives line clear for shunting. The ground signals show a small white or green light at the back according to whether they are set to line clear or otherwise.

Although the object of ground signals is to regulate shunting operations, they must, nevertheless, be observed by trains as stopping signals when they are set to the danger position.

In small and medium stations, ground signals sometimes perform the function of departure indicators. We shall mention this later.

In the sketch shown in figure 20, the ground signals a^1, a^2 and b^1, b^2 show

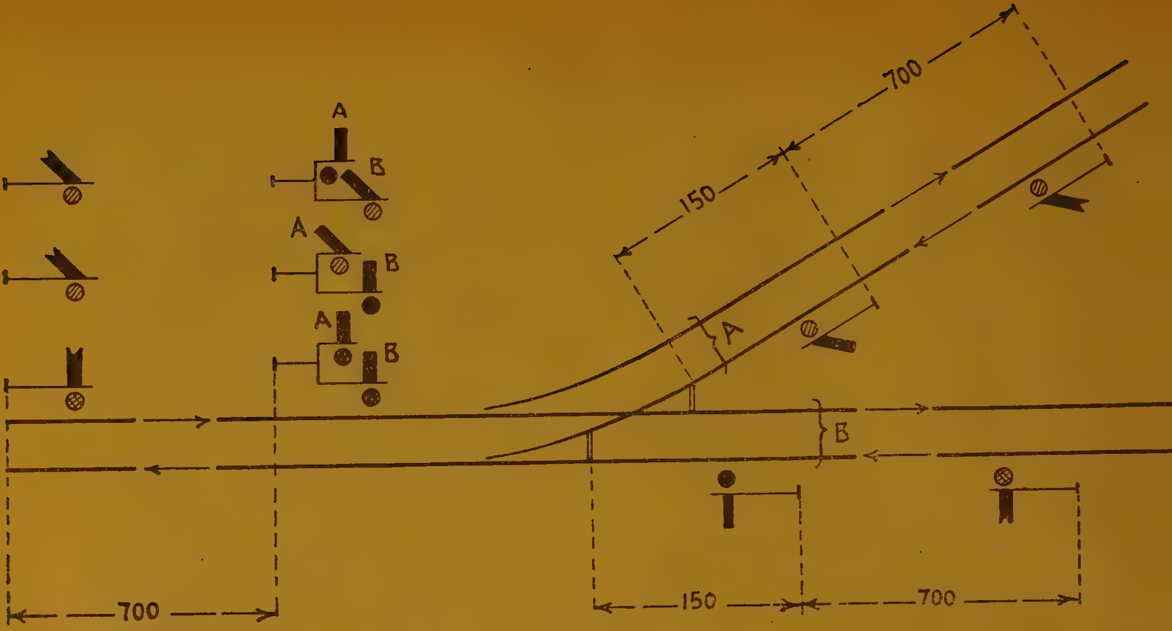


Fig. 15.

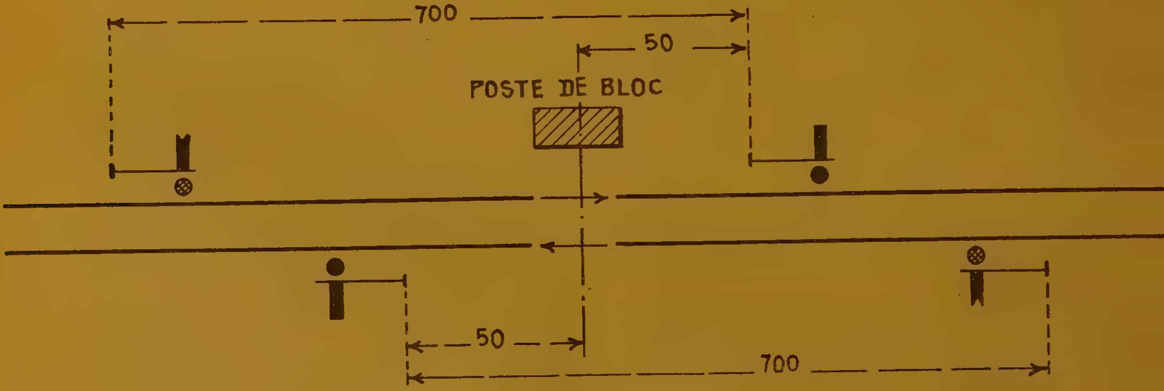


Fig. 16.

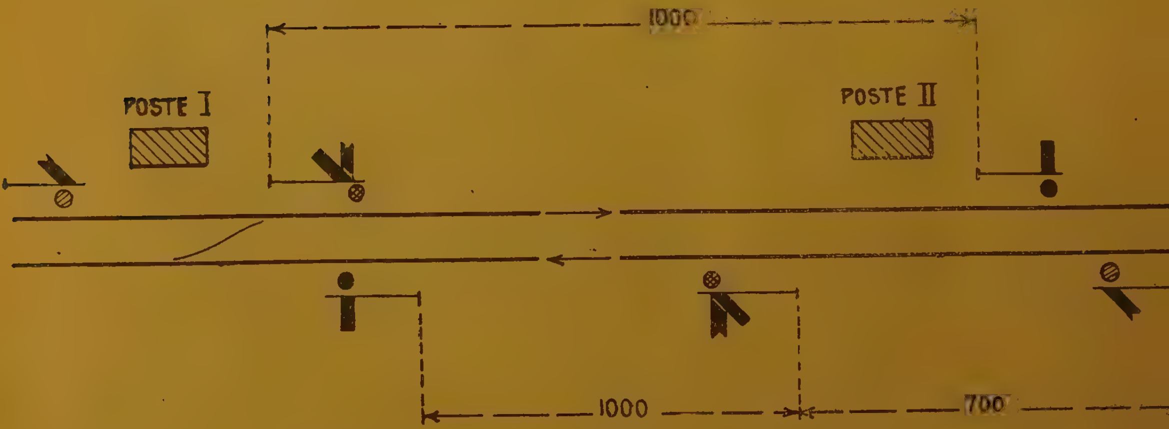


Fig. 17.

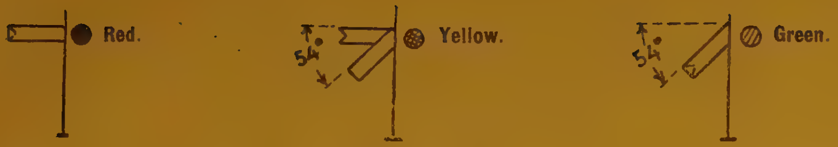


Fig. 18.

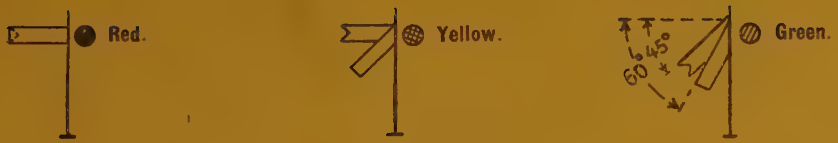


Fig. 19.

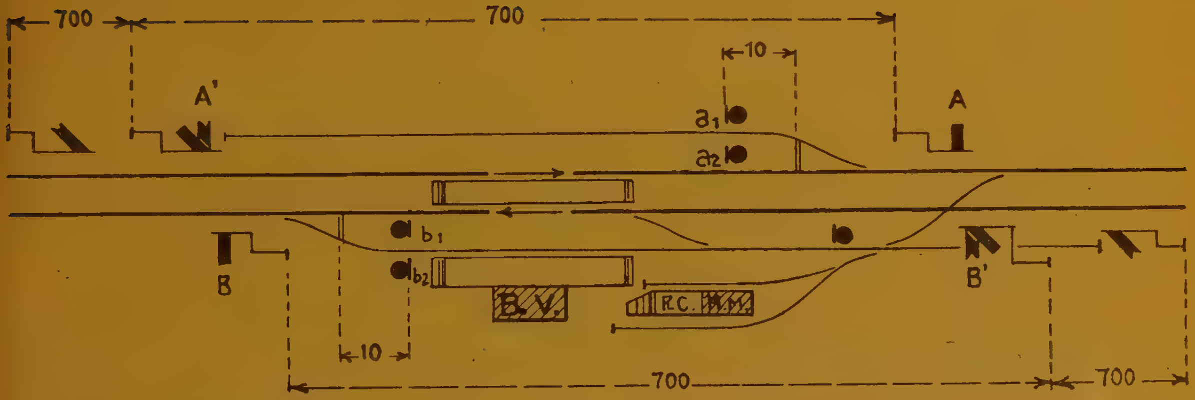


Fig. 20.

Figs. 18 to 20.

which of the two main tracks or siding tracks are given line clear by the signals A and B.

In large stations, at the ends of the tracks or groups of tracks, small semaphores are arranged with arms and lights similar to those of semaphores of the first class, called departure indicators, which, set at line clear, show the drivers that the points are set for departure over the corresponding tracks and groups of tracks. Usually, the departure indicators do not apply to shunting operations.

When the station signals comprise a departure semaphore, and this is set for line clear, with that of the departure indicator, this authorises departure or a through route for a train on the corresponding track.

At the ends of these tracks or of these groups of tracks there are also arrival indicators, the arms of which are usually placed on the same posts as the departure indicators, and show, when at line clear, that the points are set for a train to run on these tracks or on the corresponding groups of tracks.

Figure 21 shows the signalling at one side of a large main line station, a signalling system which is remarkable for its simplicity and clearness.

The protecting and departure signals, and the indicator signals for arrival and departure tracks are arranged on a signal bridge, and the ground signals for shunting are operated, as also are the points, from a single cabin.

Figures 22 and 23 represent two junction stations ;arranged on a line worked on the block system. In the first-mentioned, there is, for both directions of traffic, an internal block section comprised between the home and departure signals, that is to say, between the cabins marked post I and post II. In the second figure there are two internal sections comprised between the cabin marked posts I and II and II and III.

The cabins are interlocked with each other by means of electric slot gear acting on the signals; moreover, the entrance of the trains from the different directions, and access to the different tracks or groups of tracks is controlled by the traffic foreman at the station by means of electrically operated slotted signals. These appliances meet both the conditions of ensuring that any slot release can be used once only and for the one train for which it is given, and that each slot release, once given, can only be cancelled by the train in running over the rail contacts.

In one of the last types adopted, it is possible to arrange as many as four slot releases with a single apparatus. The construction of the apparatus, however, allows of mechanical coupling and interlocking between them in such manner as to constitute a multiple apparatus, with which as many slot releases as may be desired can be given. The slot releases are limited by the mechanical interlocking between the various appliances, an interlocking which only allows the taking off of slots that can be safety used simultaneously.

These appliances are used for the control of the various signals protecting a station, and at a distance, those of a junction.

In these two stations, the following arrangements are applied :

The slotting apparatus consists essentially of :

1° A crank which actuates the parts that complete the electric circuits for the transmission of slot release currents, which crank may take two positions : « on » (vertically downwards) and « off » (vertically upwards);

2° Two or more push buttons indicating tracks at the base of the apparatus, which are interlocked with each other by means of locking gear of the Stevens type, which control each slot circuit;

3° An internal mechanism, serving to lock the apparatus, that is to say, to interrupt automatically a slot circuit when the train passes over the « train on line » contact for the signal;

4° A second internal mechanism, that locks the crank, once the slot has been taken « off », and unlocks the crank only after the train has passed the freeing contact;

5° A current indicator serving to show whether the slot circuit is, or is not, completed (current passing).

Generally, the two functions of giving « train on line » and « line clear », are effected by the same contact.

Recently, instead of a number of appliances with one or more plungers interlocked with each other, apparatus has been constructed in which the various cranks, with the slot mechanism and that for blocking and clearing, are arranged and contained in a single box.

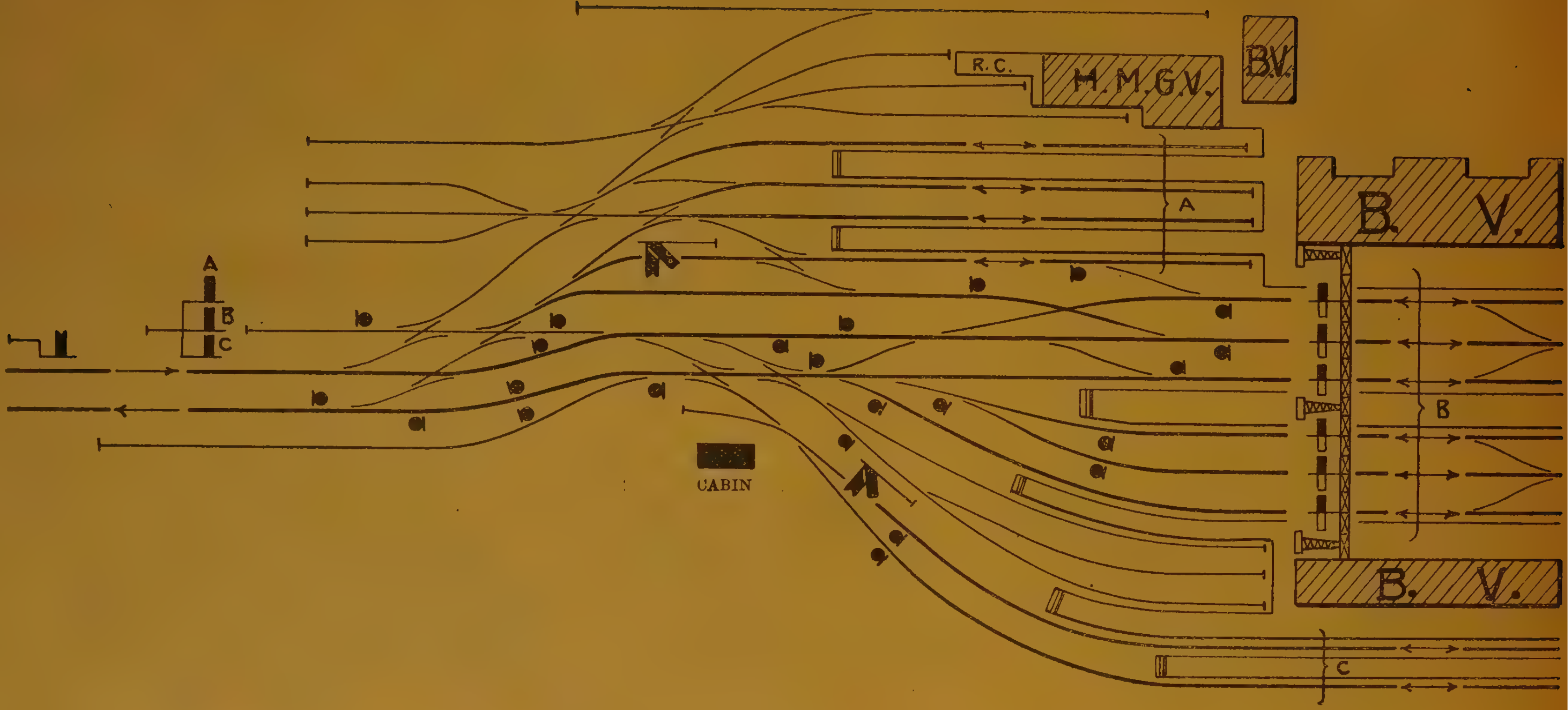


Fig. 21.

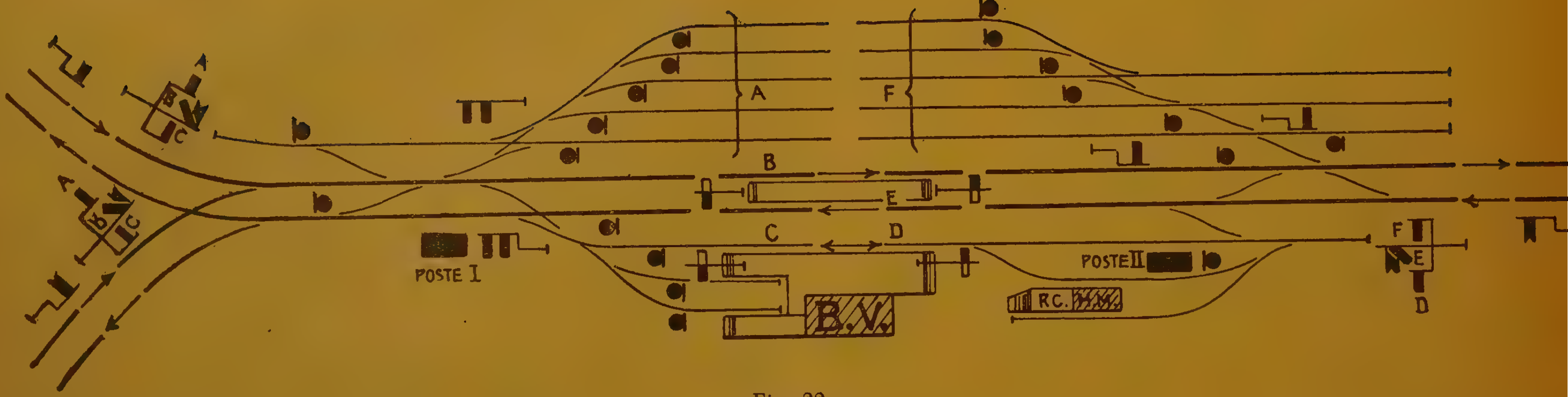

A
B
C
A
B
C
A
F
B
E
C
D
POSTE I
POSTE II
B.V.
R.C.
H.M.
F
E
D

Fig. 22.

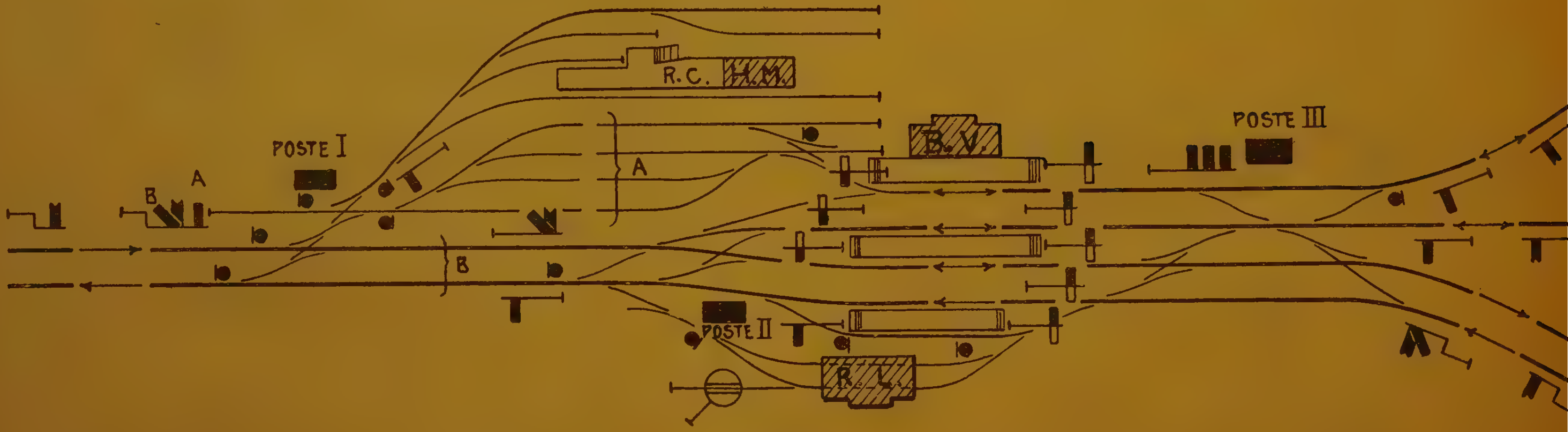

R.C.
H.M.
POSTE I
B
A
A
B
B.V.
POSTE III
POSTE II
R.L.

Fig. 23.

The arrangement of the levers in two tiers, horizontally for points and signals controlling incoming trains, and vertically for disposing of trains in the station, simplifies the internal interlocking arrangements and the manipulation of the apparatus.

Amongst the auxiliary signals, it is also necessary to mention the small point indicators operated by the point lever and showing the position which the points occupy. If they are set with the face parallel to the track, they show that the points are set for the main line, and if the face shows perpendicular to the track that the points are thrown over for the branch track. If the signals are definite track signals, the face standing at right angles to the track requires a stop to be made. These indicating signals are only used in some special cases, such for example, as the points of branches on the main line, or facing points so placed that they are difficult of observation from the station, and of points leading to locomotive sheds.

They are not used for points that are operated from the cabin.

CHAPTER IV.

The lighting of signals in Italy. — Luminous signals.

For lighting the signals, semaphores, and discs, paraffin lamps are generally used.

The sheet-iron paraffin lamps for semaphores of the Northern-Italy type are fitted with parabolic reflectors of German-silver and double reflectors in the case of semaphores with two arms opposite each other. The brass lamp with cylindrical wick and glass chimney, has a capacity of 0.75 litre (1.3 pints) and remains alight for 24 hours. The sheet-iron lamps with American burners for the ordinary semaphores and the ground signals have capacities respectively of 0.8 and 0.55 litre (1.4 and 0.9 pint) and remain alight for 43 and 30 hours respectively.

The semaphores and the ground signals are fitted with plano-convex lenses of different diameters.

The coloured glasses of the semaphores of the ordinary type, of the Northern-Italy type, and of the ground signals, have diameters of 160, 245, and 110 mm. (6 5/16 inches, 9 5/8 inches and 4 3/8 inches) respectively.

In some special cases in which signals are not visible from the signal boxes responsible for their supervision and lighting, use is made of light indicators adapted to the chimneys of the lamps of the tunnel disc-signals, to those of the Northern-Italy type, or to semaphores of the ordinary type.

The apparatus consists essentially of a spiral formed of two thin strips or ribbons of iron and brass brazed together. By reason of the difference of the coefficients of expansion of iron and brass, the spiral tends to uncoil or to coil up according to whether the lamp is alight or out; this controls the closing or the breaking of the electric indicator circuit. It is an arrangement that is reliable, provided that it is subject to continuous and careful maintenance.

To improve the visibility of the signals, and to increase the time for which the lantern will remain alight, preliminary trials were made in tunnels and in the open with flashing light of the « Aga » type, using acetylene, dissolved in acetone, contained in vessels holding 1 500 litres (53 cubic feet) with a burner using 5 litres (0.18 cubic feet) per hour.

The trials, made on a small scale, gave good results at 60 flashes per minute, the periods of flash and eclipse being 0.4 and 0.6 second respectively in duration.

The trials made it possible for this arrangement to be recommended as a means for enabling a particular signal to be distinguished amongst other lights carried on the same multiple bracket posts, or to be fitted to isolated signals which by reason of their situation have poor visibility and are difficult to supervise.

In tunnels, the superiority of the flashing light over fixed paraffin lamps is less in proportion as the smoke is thicker: for a normal smoke density visibility in the one case is nearly double that in the other.

Up to the last few years, applications of electric lighting to signals were very limited on account either of the difficulty of ensuring the lighting of the signals in the case of an unforeseen interruption of the current supply, or of the necessity for obtaining continuously and effective check on the regular working of the lamps, or, finally, of the difficulty of rapidly localising the cause, in case of failure. A more thorough examination of the question led to the conclusion that the difficulties could often be easily solved if account were taken of the fact that, at the present time, owing to the great improvement that has taken place in the distribution systems of electricity supply, and by means of the linking up of works supplying electricity, temporary interruptions of current have become much more infrequent.

In fact, on lines having electric traction, the traction current reduced suitably in voltage can be used as a stand-by to the local supply.

In places in which there are not two independent supplies of current, one of which can be used in the event of failure of the other, it is always possible to instal accumulator batteries.

In small stations on non-electrified lines which are without means for charging accumulators, and in which it is not possible to count on local supplies of current, the use of accumulator batteries cannot be justified from the point of view of economy. It would be possible, on the other hand, in the case of interruption of the current, to light the signals by means of ordinary paraffin oil lamps.

Regarding the control of the lighting from two systems of supply to a single circuit, continuous lighting is ensured by lamps arranged in series or in parallel, an extensive application of which is now being made in the stations on the Italian railway system.

In the first system, either two lamps simultaneously lighted are used at the same time, or one lamp is lighted and the other serves as a stand-by and is only lit either by operating a switch on the switch-board or automatically when the main lamp goes out, the two lamps on the signal being connected to two distinct circuits that are absolutely identical and in parallel with each other.

The lamps are of the metal filament type, for use on 23 volts, as used for lighting the trains, giving from 5 to 10 Hefner candles, according to local conditions. The lamps are mounted on lamp-holders with a bayonet fitting having flexible suspension to absorb the shock produced by the working of the signals. The lamp-holders are contained in special lanterns which can be placed on the signals in place of the paraffin oil lamps.

The signals may be conveniently grouped according to their position, and connected to circuits fitted with either permanent or adjustable resistances, in such a manner as to equalise the voltage of the circuits having the heaviest loads.

For each circuit there is a current relay on the switchboard which lights a tell-tale lamp when the lamp which is in series with it fails, or when there is any interruption in the circuit, or when the voltage drops, and which also causes a bell to ring in the case of a short circuit, or rise of voltage.

In the two-lamp arrangement in which only one of the lamps is lighted, the relay is inserted in the circuits of the lamps of both sets; it is fitted with two contact arms, the one of which controls the automatic lighting of the stand-by set of lamps when a lamp of the main set goes out, the other controlling the lighting of the standby lamp when a short circuit takes place in the lamp of the main set.

To facilitate detection, and hasten the locating of faulty lamps, special test boxes are fixed at the bottom of the signal posts, fitted with repeating-lampholders in parallel with the lamp circuit.

Recently, an electro-magnetic indicator substituted for the test boxes, has been fitted on the switchboard; it is fitted with a graduated dial that gives the resistance, in ohms, of the coils that are connected in parallel with each lamp of the installation, and in case of a lamp going out, enables its position to be determined exactly.

A single indicator suffices for the two sets of lamps for each group of signals, and can be operated by two separate push buttons.

On the switchboard is an arrangement for switching on the main or the standby supply : either by means of a hand-operated, three-way switch, or by means of an automatic switch throwing in or cutting out the standby supply at the moment of failure or of return to the normal current supply.

In lighting installations with lamps in parallel on the main circuit, each signal that is electrically lighted is fitted with two lamps of 10 Hefner candles each, the one normally lighted and the other normally out.

When a lamp that is normally lighted, goes out, the stand-by lamp is switched on.

Mr. Mario Fiachetti, chief engineer of the Italian Railways, has designed a control arrangement that satisfies the following conditions :

a) Checking at a distance, whether one or more lamps are alight;

b) Indicating immediately by optical or audible means when one or more lamps have gone out;

c) Automatically inserting other lamps to replace the lamps that have gone out, and checking that the lighting is regular;

d) Indicating any irregularity.

The arrangement is based on the following elementary principle : if a system of solenoids carried on the same core is so arranged that the algebraic sum of the ampere-turns on the solenoids is equal to zero, the resultant magnetic field is nil.

The control of n lamps is obtained by means of an electro-magnet with two coils carried on the same core and having the numbers of turns in the ratio 1 : n when a current proportional to n flows through the first coil (corresponding to n lamps at a distance in parallel) and when a current passes through the second coil, in the opposite direction, proportional to unity (corresponding to a single adjacent lamp) the total magnetic flux is nil and the core of the electromagnet is not excited.

When for any reason (interruption, leakage, short-circuiting, etc.) this state of equilibrium is disturbed, the core is excited and makes a contact which puts into circuit auxiliary lamps or indicators, optical or audible.

The system is therefore independent of the voltage, of the type of current used and of its periodicity.

This arrangement, which is described in appendix A, has in practice formed the basis of an apparatus for a simple control for each signal and for the multiple control of the signals in one direction.

The system of lighting with lamps in parallel has the advantage over the preceding system that the lamps are made independent in such manner that if any one should go out, it does not involve a whole series of lamps.

In practice, both systems have given good results; the second system is, however, less costly both in installation and maintenance.

A trial has recently been made in a small station of lighting the signals from accumulator batteries, the lamps being lighted automatically on the approach of the trains. Sufficient data has not yet been obtained to enable an opinion to be expressed on the arrangement.

In the stations at Turin and Lodi, a trial has been made of light signals constructed by the « Italian Signal Company » on the systems of the Westinghouse Brake & Saxby Signal Co. Ltd., of London. At Turin, a home signal and a distant signal were replaced by two light signals of the L-type, of long visibility; at Lodi, a home signal with two arms and a corresponding distant signal were replaced by two N-type light signals of medium range of visibility.

The results obtained are given in appendices B and C.

We think that the following conclusions may be drawn from these trials :

1° Light signals, as compared with ordinary semaphores, have the advantage of giving exactly the same indications by day and by night;

2° They have the advantage over ordinary semaphores of simplifying the operating and indicating mechanisms. The probabilities of error in working and of false indication due to external causes are reduced to the minimum;

3° They lend themselves readily to giving three readings (stop, slacken, and line clear at normal speed), and to being slotted;

4° They can readily be adapted to lines having electric traction on which the visibility of the semaphores is always limited, and on which the traction conductor is available for electric supply to the signals either normally or as standby;

5° In most cases, the signals need not be duplicated in the tunnels, or under bad atmospheric conditions, by audible signals (fog signals, detonators, gongs, etc.) or by optical signals (repeating signals, approach bars, etc.);

6° Apart from the cost of installation, the maintenance is much less costly than that of the ordinary semaphores.

As a consequence of the results obtained from the trials just mentioned, light signals having one and three kinds of lights were recently installed in the Sestri-Levante station in place of the semaphores, and have worked regularly up to the present time. We think that the small difference in price between the normal range (N-type) and that of the long range of visibility (L-type), should give the preference to the latter type, for the reason that this can be easily altered when a small range of visibility only is required.

All signal apparatus should comprise two lamps with bayonet-catch holders, each with two filaments and two contacts, and the lamps should be so made as to ensure that the socket end is at the correct distance from the focus of the lamp in order that replacement of the lamps may be easy.

The front lamp should normally be lighted, the other serving as the stand-by. The arrangement proposed by Mr. Fiachetti, the engineer, for automatic lighting of the stand-by lamp, if one of the two filaments of the normal lamp should fail, should also be adopted.

According to the range of visibility required, the lamps should all be either 50 or 30 watts, and 30 volts.

On the Italian railways, trials of position light signals giving the same indications as the semaphore arms with the lighting of four lamps, or of a group of several lamps, arranged on a horizontal, vertical, or inclined line, have not yet been made.

No trial has been made for lighting the signal arms at night by means of reflectors with a view to abolishing the ordinary coloured lights.

CHAPTER V.

Research in signalling.

In the preceding chapters we have given a résumé of the present conditions of signalling on the Italian State Railways.

It appears, however, to be of interest to mention a modification of the signalling system, a scheme which was worked out in 1917 by Mr. Alphonso Zanotta, engineer, chief inspector of the Italian State Railways. His is a name dear to all of us who can remember a chief of great ability and learning and a devoted friend. Our colleagues of the Congress, who did not have the good fortune to know him personally, will remember him as the reporter on the question of « Junctions » at the Congress in London in 1895.

In his opinion, the main conditons which should be satisfied by a rational signalling system are the following :

1° Each signal, giving line clear, should give the driver the necessary indication to enable him to regulate his speed as far as the succeeding signal;

2° Although it is desirable that the signals should be of one shape, and have lights and positions making them visible at a long distance, they should nevertheless, according to their meaning, be arranged in an order of succession that will enable their readings to be obeyed, even when their visibility at a long distance is reduced to the minimum compatible with safety (at any rate in the open air), under normal atmospheric conditions, whatever may be the plan and section of the line.

It is of course necessary to rely on these visible signals being supplemented by audible signals in the case of fog, and this applies also to those signals that are placed in tunnels;

3° New signals should be so designed as to take account, as far as possible, of the recognised meanings of forms and colours in such manner that no omission or defect may exist. It is also necessary to avoid possible causes of confusion in the reading of signals when signals of the new type and of the existing type are simultaneously in use on the same line, and might be mistaken for each other;

4° In the case of combined signals, it is necessary to avoid simultaneously showing the driver signals giving different readings in cases where one alone of these signals would be sufficient to give the exact order which the driver must obey;

5° The reading of a signal should not be altered, through a lamp going out or having a broken glass, in such manner as to give a less restrictive order;

6° The single white light, or the white light by itself, that is to say, not used in combination with a coloured light or lights, must not replace a signal intended to give the instruction « line clear ».

The white light should only be used for indicating the presence of a signal that is not in use. In order that the white light may give instructions, it must be combined with another positive signal comprising at least one coloured light, otherwise it must be considered as arising from a broken glass;

7° The indicator signals used exclusively in stations for giving the routes and the shunting signals should, when at line clear, be distinguished by the form and colour of the main signals that regulate the running of the trains.

In applying these principles, Mr. Zanotta, the engineer, proposed to use the following position and indications for the new signals :

a) Home semaphore with one « stop » arm having three positions;

b) Distant semaphore having three positions;

c) Semaphore with two combined arms, home and distant, giving five positions.

The arm of the new home semaphore is of rectangular form, having the face towards the train painted red, as in the ordinary semaphores.

Its inner end of circular shape turns with the arm in front of a lamp carried on the post, and has in it the spectacle holes fitted with coloured glasses (as shown in figures 24 to 26). The arm can occupy three positions : horizontal, inclined downwards at 45°, and inclined upwards at 45°. In the first case, there is a single glass arranged on the horizontal diameter of the arm, in the other cases there are two. The lamp is fitted with reflecting mirrors, enabling it to show the train two luminous beams of light when two holes are on the horizontal line through the centre.

The arm of the new distant semaphore with a fishtail end is painted yellow like the ordinary distant semaphore arms. It is also fitted with a circular plate at the centre, with holes fitted with coloured glass as in the home signal. In the semaphore with combined home and distant arms, the plates on the two arms are in front of each other, and each arm, apart from the three positions which we have mentioned, can occupy a fourth position without special meaning, vertically downwards.

In this case, the order is given to the driver by the other arm, which does not occupy a vertical position.

The centre plates of the two combined arms are also provided with holes fitted with coloured glasses.

According to the positions of the arms, the two plates which are in front of each other give through one hole or the two holes which come on the horizontal line, the light or the lights corresponding to the various indications of the arms. The indications given by the home signal day

HOME SIGNAL :

Absolute stop :

Arm horizontal
Red light at night

Proceed at normal speed :

Arm inclined downwards
Two green lights at night.

Proceed at reduced speed :

Arm inclined upwards
Green and white lights at night.

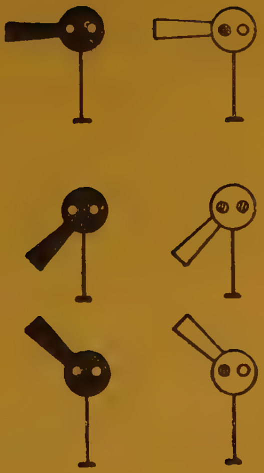


Fig. 24

DISTANT SIGNAL :

Reading : home signal at danger.

Arm horizontal
Yellow light at night

Reading : proceed at normal speed.

Arm inclined downwards
Two green lights at night.

Reading : proceed at reduced speed.

Arm inclined upwards
Yellow and green light at night.

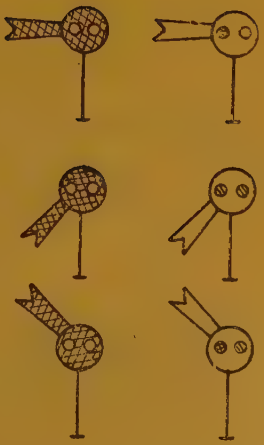


Fig. 25.

and night are those shown respectively in figure 24.

The indications given by the distant signal are those shown in figure 25.

The indications given by the combined double arm signal, home and distant, are given in figure 26.

Of the five indications, three are the same as those of the home signal having a ling system applied to the protection of of a distant signal.

Home and distant signals in tunnels, as well as the combined double signals (home and distant) give the same indications as are shown by the semaphore signals at night.

The tunnel signals are fitted with a lamp giving a single light and have reflectors carried on the posts.

Inside the lamp is fitted a single diaphragm for the single signal, or two diaphragms for the double signal.

COMBINED HOME AND DISTANT SIGNALS :

Absolute stop :

Home-arm at danger; distant-arm covered by home-arm

Red light at night

Proceed at normal speed :

Home-arm inclined downwards; distant-arm vertically downwards

Two green lights at night

Proceed at reduced speed :

Home-arm inclined upwards; distant-arm vertically downwards

Green and white lights at night

Reading : next home signal at danger

Distant-arm horizontal; home-arm vertically downwards.

Yellow light at night

Reading : Proceed at reduced speed

Distant-arm inclined upwards; home-arm vertically downwards

Yellow and green lights at night

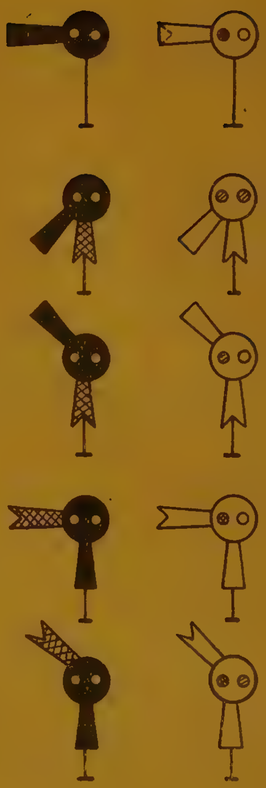


Fig. 26.

The diaphragms are pierced with holes, fitted or not fitted with coloured glasses, as in the case of the semaphore arms.

The diameters of these diaphragms are slightly less than those in the circular plates of the arms, in order to suit the loading gauge. The lights are arranged about 40 cm. apart instead of 50 cm. (1 ft. 3 3/4 in. apart instead of 1 ft. 7 5/8 in.) as on the semaphores.

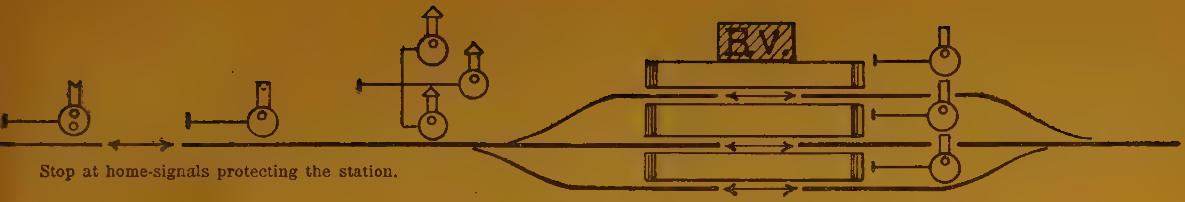
In appendix D, we give details of the construction and working of the new semaphores.

In figure 27, we show the new signalling system applied to the protection of one side of a little-used station.

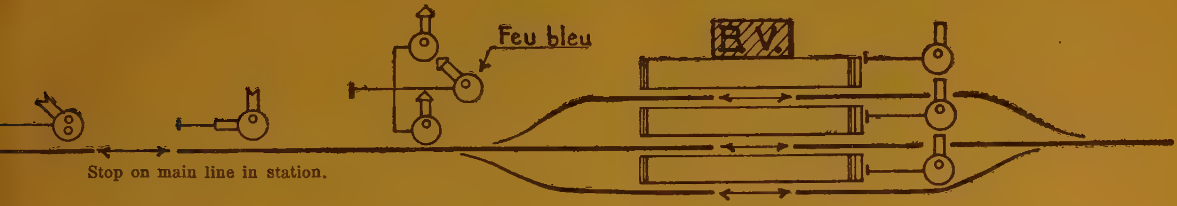
Apart from the home and distant signals, the direction-indicator signal is shown which should be placed near the points at the entrance to the station.

The arm of the indicator signal is painted blue, and has a pointed end. It can occupy two positions : horizontal (white light at night), inclined downwards (blue light at night).

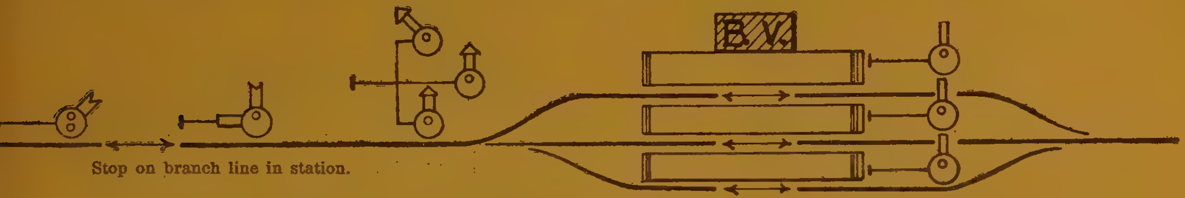
This signal is not used in the case of two tracks giving access to the station, because the home signal gives absolutely-clear road or road clear at reduced speed, and consequently gives the driver the indication as to whether he will follow the through or branch road.



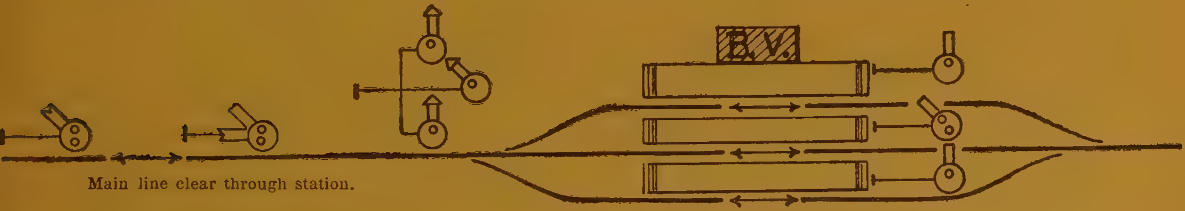
Stop at home-signals protecting the station.



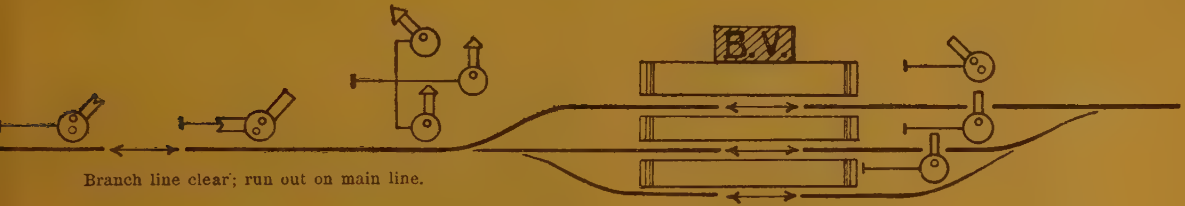
Stop on main line in station.



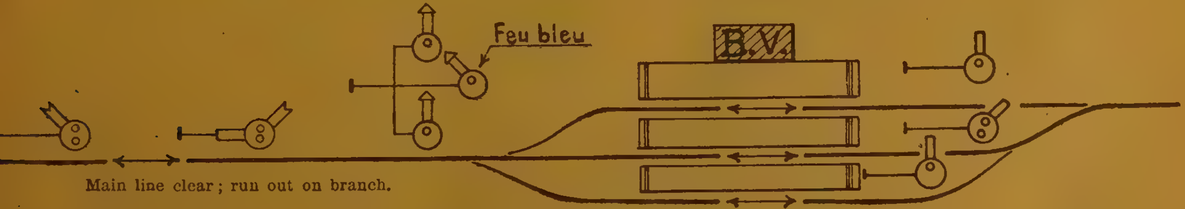
Stop on branch line in station.



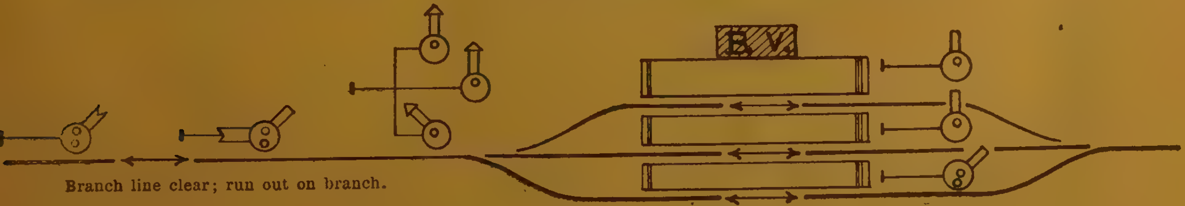
Main line clear through station.



Branch line clear; run out on main line.

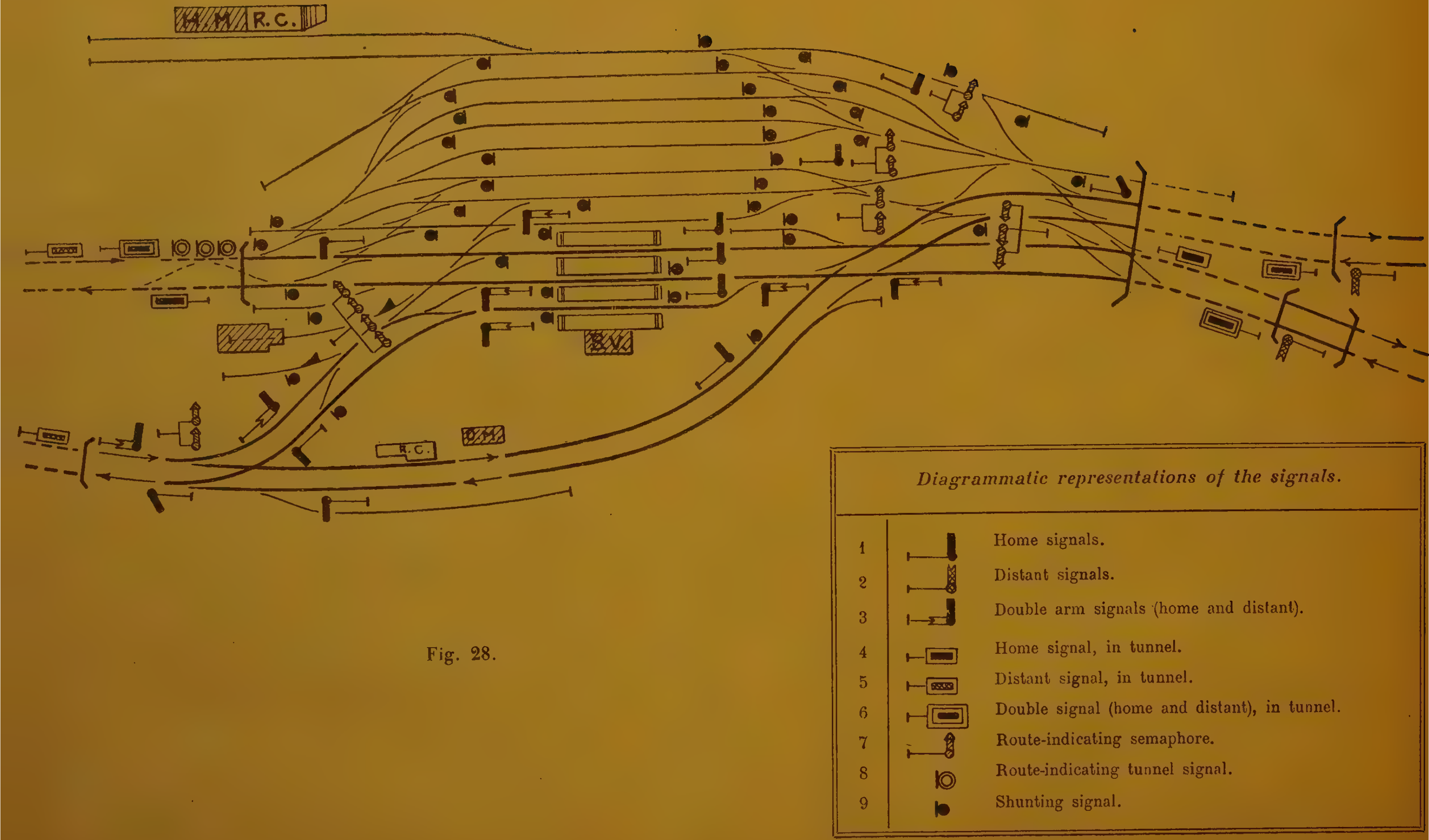


Main line clear; run out on branch.



Branch line clear; run out on branch.

Fig. 27. — Station signals.



Diagrammatic representations of the signals.

1	Home signals.
2	Distant signals.
3	Double arm signals (home and distant).
4	Home signal, in tunnel.
5	Distant signal, in tunnel.
6	Double signal (home and distant), in tunnel.
7	Route-indicating semaphore.
8	Route-indicating tunnel signal.
9	Shunting signal.

Fig. 28.

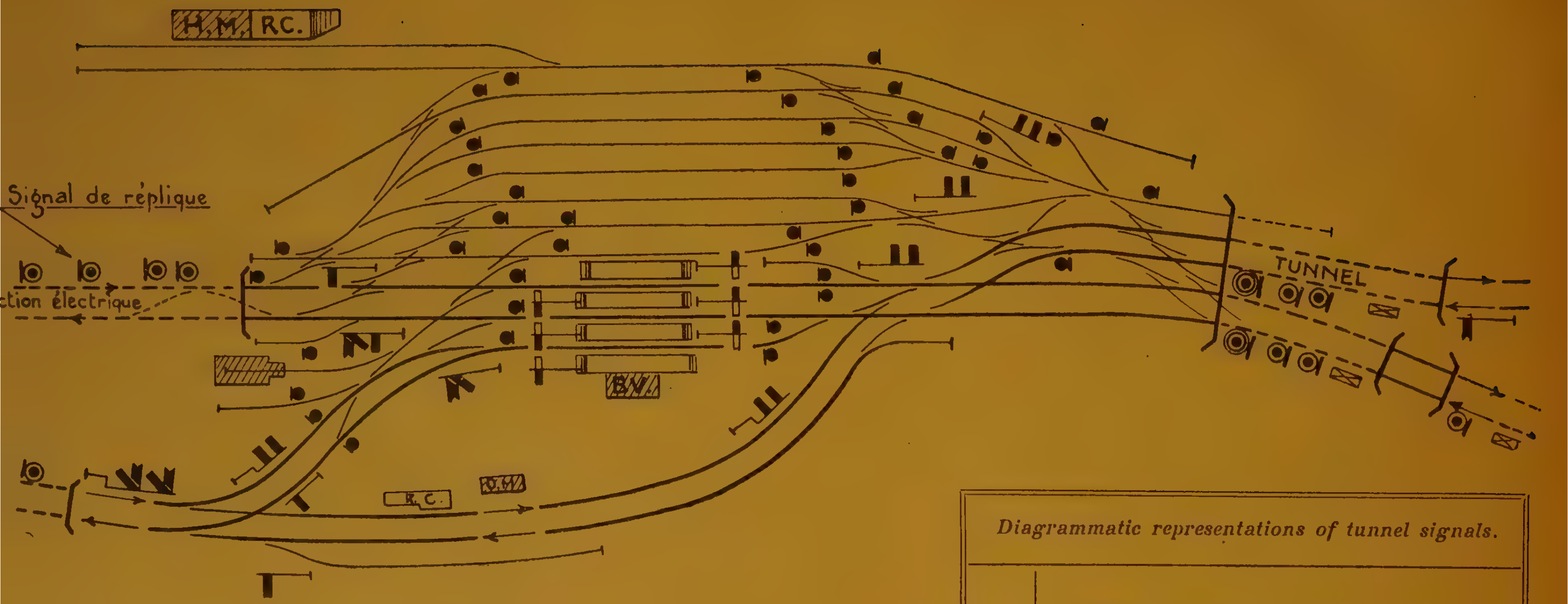


Fig. 29.

Diagrammatic representations of tunnel signals.

1	◎	Double light signal (home and distant).
2	●	Single light signal (home and distant).
3	☒	Detonator signal.

Translation of French terms: Signal de réplique = Repeating signal.

Figures 28 and 29 show, for the junctions of a large station, the application of the new signals and those at present in use.

The scheme for signalling used by the engineer, Mr. Zanotta, which, in its general arrangement, shows an improvement on the present system, has not yet been examined by the responsible Commission.

While Mr. Zanotta was working out a standardised signalling system, we, on our own account, also investigated the question, giving our attention particularly to those points which in our personal experience required improvement.

There can be no doubt that it is necessary to warn the trains to reduce speed at special points on the road, in order to avoid difficulties of working, which, on many occasions, have had very serious consequences. In adopting the double signalling arrangement, in which the home signals are preceded by distant signals, it is certainly of advantage that the home signal, in its danger position, by day and by night, should have a form and lights that are quite distinct and cannot be mistaken, owing to atmospheric disturbance, for those of the corresponding distant signals.

We remember that on many occasions on lines carrying the heaviest traffic, worked on the block system, that during fog, stops have been made at the distant signal when occupying its horizontal position, because the yellow lamp, having a slightly red tint, had been mistaken for the home signal at danger. And sometimes under the same working conditions and state of the atmosphere, the opposite has happened, that is to say, a home signal, particularly one with combined double arms, set at danger, has been overrun because it has been taken for a distant signal.

Given that the English arrangement of the two arms, home and distant, arranged above each other, may give rise to wrong readings in places where, as on electrified lines and in tunnels, it is necessary to adopt arms and lights, arranged above each other, instead of bracket signals, the Italian arrangement of coupling two arms becomes necessary. In our opinion, however, the coupling should be done in such manner that both arms may be visible in their different positions.

The simplification which consists in eliminating one arm or one light (and this has been done on personal judgment and in isolated cases) is desirable, provided that it is not applied in such manner as to take the place of the double signalling arrangement, as this would lead to confusion in the reading of successive signals. That is to say, that in the combinations there should be perfect conformity between the day and night readings. The lights at night should be the same as if the signals were separate and one below the other or one following the other.

In groups of signals having several protecting arms at junctions and stations, the simultaneous use of arms or lights showing train on line, and an arm or light showing line clear, constitutes an undoubted anomaly. For this, it is advisable that the arms that do not relate to the route that has been cleared should occupy a special position; for example, vertically downwards and show a white light at night. Moreover, the distant signal of a bracket semaphore should generally, by the arrangement of its arms, reproduce the position of the signal to which it relates, while maintaining its own characteristic features, in order that it may avoid the giving of wrong-road signals with the present Italian signalling system, as has already occurred many times at junctions on the main line.

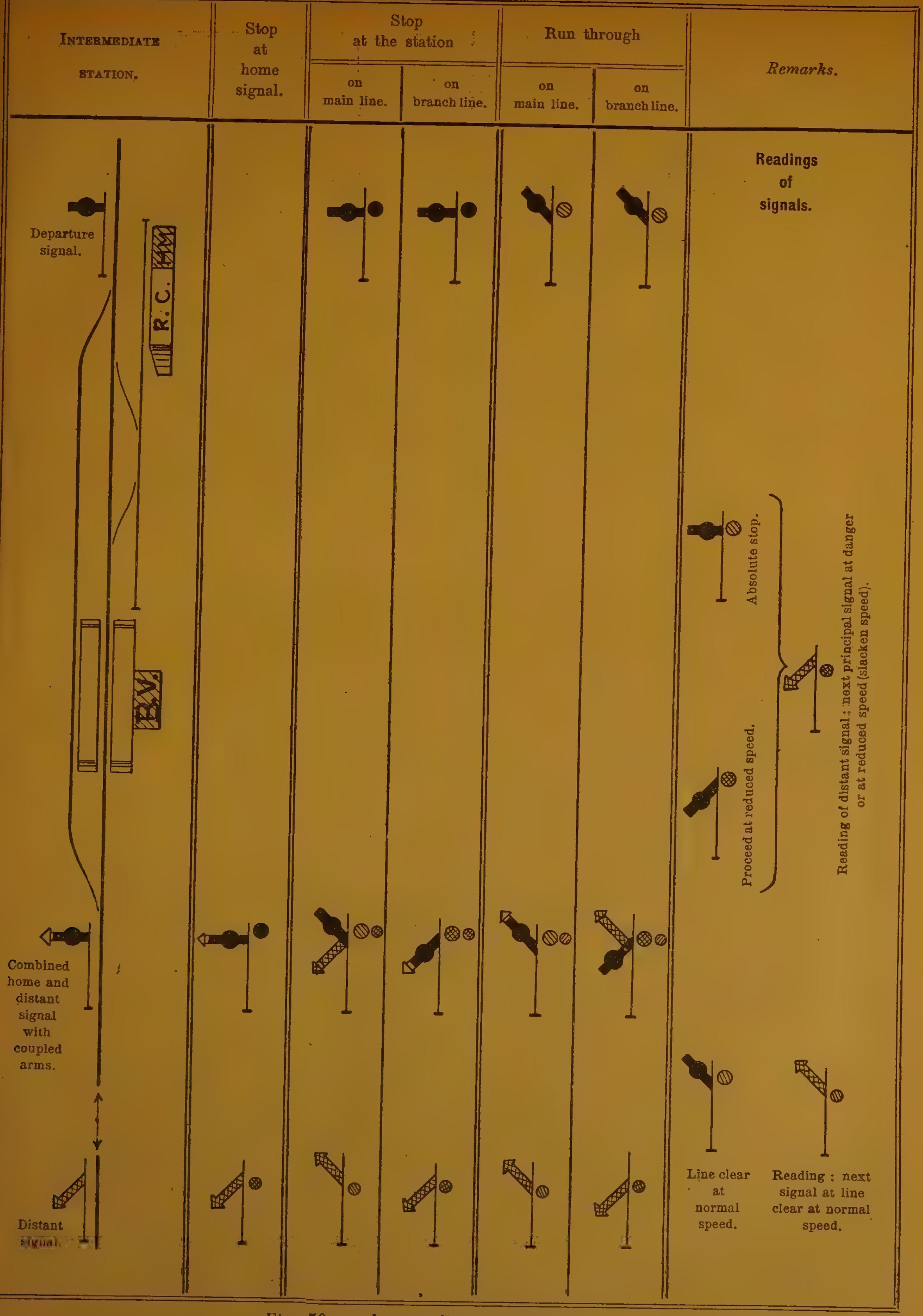

INTERMEDIATE STATION.
Stop at home signal.
Stop at the station
on main line.
on branch line.
Run through
on main line.
on branch line.
Remarks.
Readings of signals.
Departure signal.
R. C.
B.V.
Combined home and distant signal with coupled arms.
Distant signal.
Absolute stop.
Proceed at reduced speed.
Reading of distant signal: next principal signal at danger or at reduced speed (slacken speed).
Line clear at normal speed.
Reading: next signal at line clear at normal speed.

Fig. 50. — Intermediate station signals.

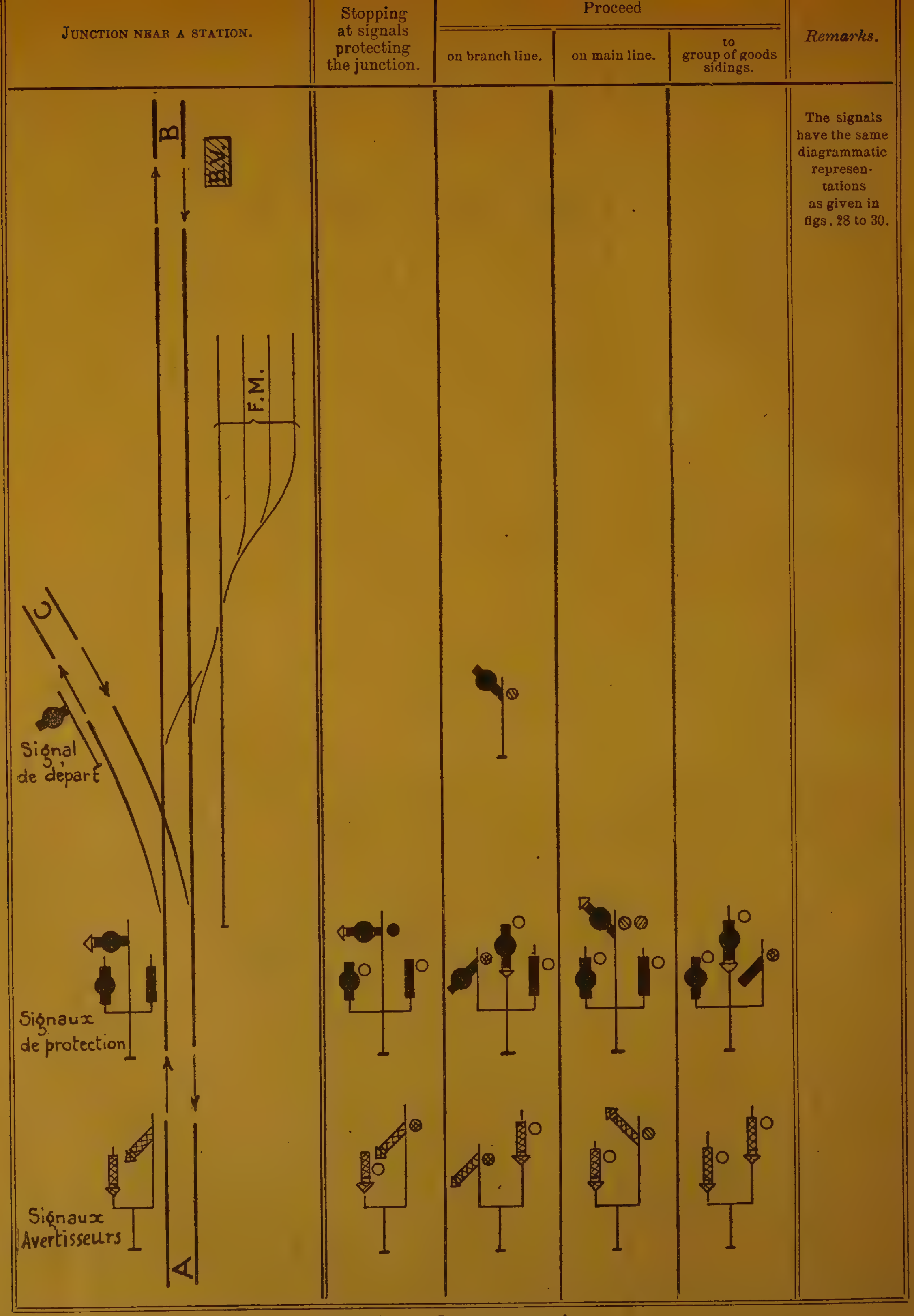

Junction near a station.
Stopping at signals protecting the junction.
Proceed
on branch line.
on main line.
to group of goods sidings.
Remarks.
B
B.V.
F.M.
C
Signal de départ
Signaux de protection
Signaux Avertisseurs
A
The signals have the same diagrammatic representations as given in figs. 28 to 30.

Fig. 31. — Junction signals.

Translation of French terms :

Signal de départ = Departure signal. — Signaux de protection = Home signals. — Signaux avertisseurs = Distant signals.

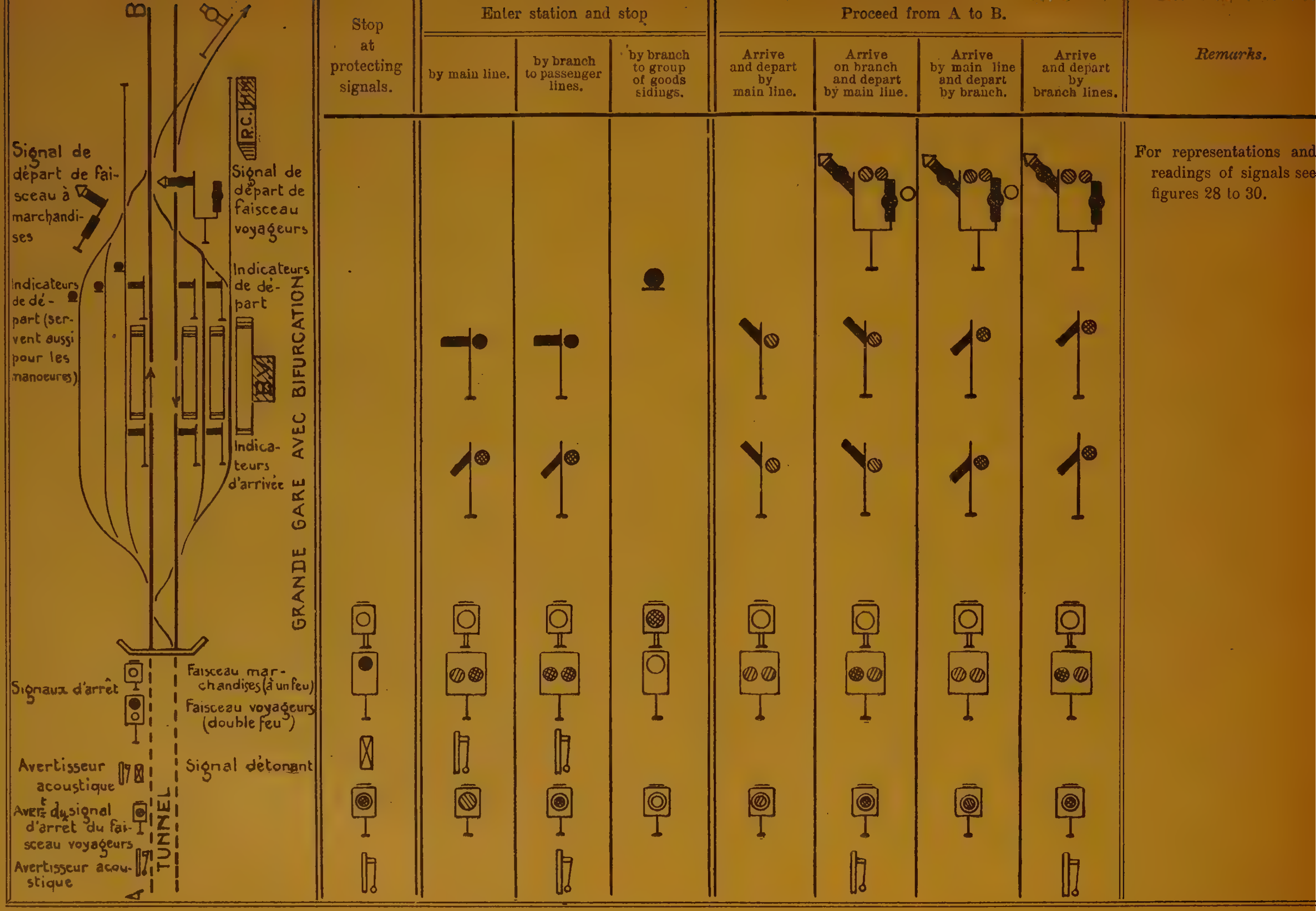

B
R.C.
Signal de départ de faisceau à marchandises
Signal de départ de faisceau voyageurs
Indicateurs de départ (servent aussi pour les manoeures)
Indicateurs de départ
B.V.
Indicateurs d'arrivée
GRANDE GARE AVEC BIFURCATION
Signaux d'arrêt
Faisceau marchandises (à un feu)
Faisceau voyageurs (double feu)
Avertisseur acoustique
Signal détonant
Avert. du signal d'arrêt du faisceau voyageurs
Avertisseur acoustique
TUNNEL
A
Stop at protecting signals.
Enter station and stop
by main line.
by branch to passenger lines.
by branch to group of goods sidings.
Proceed from A to B.
Arrive and depart by main line.
Arrive on branch and depart by main line.
Arrive by main line and depart by branch.
Arrive and depart by branch lines.
Remarks.
For representations and readings of signals see figures 28 to 30.

Fig. 32. — Signals at a station with a junction.

Translation of the French terms of the figure 32.

Grande gare avec bifurcation = Large station with a junction. — Signal de départ de faisceau à marchandises = Departure signal from goods sidings. — Indicateurs de départ (servent aussi pour les manœuvres) = Departure ground signals (also used for shunting). — Signaux d'arrêt = Home signals. — Avertisseur acoustique = Audible distant signal. — Avertisseur du signal d'arrêt du faisceau voyageurs = Distant signal for passenger lines. — Signal de départ de faisceau voyageurs = Departure signal from passenger lines. — Indicateurs de départ = Departure indicator arms. — Indicateurs d'arrivée = Arrival indicator arms. — Faisceau marchandises (à un feu) = Goods lines (single light). — Faisceau voyageurs (double feu) = Passenger lines (double lights). — Signal détonant = Detonator (fog) signal.

With the object of simplification, and because it is not required in practice, the home signal arms protecting the station, relating to the entrance to the groups of goods sidings, should not be supplemented by distant signals. With regard to the signals arranged inside the stations, we think that the route indicators at the entrance and departure, which at present consist of semaphores of small dimensions, should, in case of need, give three readings, as is the case with the principal signals. Also, on the arms and on the lights, the numbers of the tracks to which they refer should be clearly shown.

The ground shunting signals should not be modified from the present rectangular shape, which was given to them in order to allow them to be placed in the ordinary six-foot way.

While taking these remarks into consideration, we have proposed the modifications to the existing signalling system that are shown in figure 30.

This figure shows that the arrangements of the arms and of the corresponding lights, in the coupled home and distant signals, are simple, and differ gradually from each other by their colours, and consequently are easily memorised.

With this arrangement of lights, one does not find the repetitions between some arrangements of home signals with a single arm and other arrangements of coupled home and distant signals that are found in the system proposed by Dr. Martens in his work : *The Principles of Railway signalling for high speed traffic, taking account of the action of the brakes* (1), although the one and the other have different meanings.

Figure 31 shows the signal arrangement for protecting a junction.

Figure 32 shows the signal arrangement for protecting a large station having a junction.

In these figures, the signalling refers to the route AB and to the routes to the groups of goods tracks.

The disk with several lights arranged above each other, which protects trains in the tunnel arriving on the passenger tracks, and goods tracks, is of the ordinary type except for the arrangement of the coloured roundels.

If the conditions in the tunnels actually so require (except on electrified lines), the distant signal as well as the home signal should be supplemented by audible signals. The audible signal or distant signal only comes into operation when the distant disk is set for slacken speed; the audible signal supplementing the home signal only works when this is at danger.

The two indications that are proposed for the distant signal were suggested by the following requirements.

---

(1) « Les bases de la signalisation des chemins de fer en vue d'un service à grande vitesse en tenant compte de l'effet des freins. »

A train running at a speed of 100 km. (62.4 miles) per hour, requires 500 m. (550 yards) in which to reduce speed to 30 km. (18.6 miles) per hour in order to limit the negative acceleration to 0 m. 7 (2.30 feet) per second.

In considering existing distances between the distant signal and the home signal (in practice from 500 m. to 1 000 m. maximum — (from 550 to 1 100 yards) and taking account of the minimum visibility required for the home signal (100 m.) —, the train having run over the distance necessary to reduce its speed from 100 to 30 km. (62 to 18.6 miles) per hour, will be able to receive the warning of the principal signal, and continue at reduced speed or to stop before the home signal. The same applies if the reduced speed required is 60 km. (37 miles) per hour, taking account of the fact that to slacken from 100 km. to 60 km. per hour, requires a distance of 350 m. (380 yards) and that to come down from the speed of 60 km. per hour to a stop requires 200 m. (220 yards). It would not, therefore, be prudent as Mr. Kohlfurst, the engineer, proposes, in his work on the « Adoption of Certain General Principles in Signalling », to give the arm of the distant signal when inclined downwards, the meaning « warning », and when inclined upwards, the meaning « line clear », equally for normal speeds and for reduced speed, particularly when, under some conditions that are either atmospheric or due to the track itself, the visibility of the home signal is reduced to a very short distance.

We venture to think that the statement of our ideas is not without value, if only to show that it is possible to devise a signalling system that can satisfy the requirements of the service, and at the same time effect a satisfactory compromise between the various tendencies and the results of experience.

CHAPTER VI.

Summary.

To sum up; the new signalling system adopted by the Belgian State Railways on its main lines is essentially as follows :

1° The home semaphore, with a red arm of elongated rectangular form, and the distant signal with a pointed arm, have three positions and indications as follows:

Absolute stop (arm horizontal, red light);

Proceed, next signal at danger (arm inclined at 45°, yellow light);

Line clear, normal speed (arm vertical, green light);

Proceed, next signal at danger (arm horizontal, yellow light);

Proceed, with « attention » (*caution*), *« reduce speed at next signal »* (arm inclined at 45°, two lights, yellow and green);

Line clear, normal speed (arm vertical, green light).

In order to warn the driver of his approach to the distant signal, this is preceded by five horizontal boards, arranged obliquely with regard to the track, which have been found sufficient even in foggy weather.

Nevertheless, in foggy weather some home signals may be supplemented by fog signals of the Duplex type, put in place by fogmen. In protecting a danger point (a very busy level crossing, a swing bridge, a halt, or a block post), the two intermediate positions of the home and distant signals are not used;

2° Substitution for the English arrangement of two arms arranged above each other (home and distant), or for the Italian arrangement of two coupled arms, of a single rectangular arm used in three positions :

Absolute stop (arm horizontal, red light);

Proceed, next signal at danger (arm inclined, yellow light);

Line clear, normal speed (arm vertical, green light);

3° Replacement of the bracket carrying multiple distant signals for the junctions, according to the English system, by a semaphore having a single arm with three positions and a pointed end. This is a signal for fast trains having the following indications :

Proceed, next signal at danger (arm horizontal, yellow light);

Proceed, with « attention », « slacking at next signal, which is set at proceed on the branch line », (arm inclined, two lights, yellow and green);

Line clear, normal speed; the arm relating to the main line is at line clear (arm vertical, green light);

4° In the case of a block post and junction near together, the single distant arm which repeats the indication of the next bracket signal is placed below the home signal arms of the preceding signal : this combined signal gives four indications and meanings as follows :

Absolute stop (both arms horizontal, a red light);

Proceed, next signal at danger (home signal arm inclined and distant signal arm horizontal, a yellow light);

Proceed with caution. The next signal is set at proceed on the branch line (home signal arm vertical and distant signal arm inclined, two lights, yellow and green);

Line clear, normal speed. The next signal is at line clear for the main line (both arms vertical, one green light).

Reductions have been made in the number of lights corresponding to the three combined positions occupied by the home and distant arms.

The rules laid down are readily applicable to the more complex case of two junctions close together;

5° The home signal is generally placed 50 m. (55 yards) from the danger point. On the level, the distant signal is placed at 800 m. (880 yards) from the home signal.

On down grades this distance may be increased to 1 000 m. (1 100 yards); on up grades it may be reduced to 600 m. (660 yards);

6° The express lines are worked on the lock and block system, with Siemens & Halske apparatus interlocked with the signals.

The automatic block system has not yet been installed.

The block semaphore and its distant signal are of the same shape as ordinary signals.

7° At large stations, the route cleared for the trains is shown by means of arms arranged horizontally, and combined with numbers. Operations of shunting or setting back to sidings are controlled by means of arms of small dimensions which can be placed in the three following positions :

Stop (arm horizontal, violet light);

Short or limited shunting operation (arm inclined, yellow light);

Operation not limited or setting back (arm vertical, green light).

In the large stations, the successive signalmen's posts act, in the case of a main line, as block posts, without the intervention of the traffic foreman for receiving the trains;

8° Electric lighting (controlled by diagram boards with indicator lamps and bells) is applied in those stations in which the points and signals are operated electrically, and in some stations on the main line where there are two sources of electric supply.

No trial has been made of light signals.

⁂

The signalling system adopted by the Netherland Railway on its main lines is essentially as follows :

1° *a*) The home semaphore with a red arm of rectangular form ending in a sector of a circle, and *b*) the distant signal having the form of an elongated rectangle, can occupy two positions and give the following readings :

a)
- *Absolute stop* (arm horizontal, red light);
- *Line clear* (arm inclined at 45° upwards, white light);

b)
- *Proceed, next at danger* (arm inclined at 45° downwards, green light);
- *Proceed, next signal at proceed* (arm inclined at 45° upwards, white light). To mark the approach of the distant signal, it is preceded by two horizontal white boards.

In time of fog, fog-signals placed by fogmen, are sometimes used.

2° At junctions, at the entrance to stations, the home signals the ends of which have a V-notch (or fishtail end) are carried on brackets : they are repeated by a distant signal with two arms giving the following readings :

Proceed, next signal at danger (one arm inclined at 45° downwards, and one arm vertical, two green lights);

Proceed, next signal at proceed at a speed exceeding 45 km. (*28 miles*) *per hour*, (one arm inclined at 45° upwards and one arm vertical, two white lights);

Proceed, next signal at proceed at a speed not exceeding 45 km. per hour (one arm inclined at 45° upwards and one arm inclined at 45° downwards, one green and one white light).

3° The home signal is generally placed at a distance of 100 m. (110 yards) from the danger point; the distant signal is placed at a distance of about 500 m. (550 yards) from the home signal. The approach signal is always placed at 850 m. (930 yards) from the home signal.

4° Lines carrying express traffic are worked on the original Siemens block system. There is no automatic block. The block semaphore and its distant signal have the same forms as the ordinary signals.

5° In large stations, signals of various forms, semaphores, round disks, point indicators, etc., are used for service tracks; these signals give special readings. The successive pointsmen's posts in the case of main lines take the functions of block posts. The intervention of the stationmaster is required for operating the signals for accepting the trains.

6° Paraffin oil is generally used for the lamps lighting the various signals; but electric lighting is used in many cases.

Some distant signals are fitted with « Aga » flashing lights.

Trials of light signals are being made.

* * *

The present signalling system in use on the Italian railways is essentially as follows :

1° The home signal with a rectangular arm, painted red, and the distant signal, having an arm notched at the end and painted yellow, can occupy two positions, and give the following indications :

Absolute stop (arm horizontal, red light);

Proceed (arm inclined downwards, green light);

Proceed, next signal at danger (arm horizontal, yellow light);

Proceed, next signal at proceed (arm inclined downwards, green light).

In time of fog, the distant signals are supplemented by fog signals placed either by hand or by mechanical means.

In tunnels, the semaphores are placed by disks showing the same lights as the semaphores.

The distant disks are supplemented by audible signals.

2° Where a home signal is combined with the distant signal of the next post, the two arms are carried on the same spindle and can occupy three positions giving the following indications :

Absolute stop (arm horizontal, red light);

Proceed, next signal at danger (home signal arm inclined downwards at 45°; distant signal arm horizontal, yellow light);

Proceed, next signal at proceed (both arms inclined downwards, green light).

In tunnels, the semaphores with combined arms are replaced by disks with three lights.

3° The home signal with several arms or on brackets for protecting a junction or a station, is preceded by an ordinary distant signal, which can be set in two positions.

4° The home signal is placed about 150 m. (165 yards) from the danger point. On the level, the distant signal is placed at about 700 m. (770 yards) from the home signal; on down grades, this distance may be increased up to 1 000 m. (1 100 yards); on up grades it may be reduced to 400 m. (440 yards).

5° The main lines are worked on the Cardani-Servettaz block system for apparatus interlocked with the signals and track circuits giving occupation and clearing of the sections and actuated by the trains. The block semaphore and its distant signal have the same form and the same meanings as the ordinary signals.

6° In large stations, small home signals arranged at the ends of the tracks or of the groups of tracks, known as arrival and departure indicators, indicate arrival and departure on each track or on each group of tracks.

Shunting operations are controlled by means of ground disks with two aspects : stop (red light) clear for shunting (green light); they are interlocked with the points of the route which they protect. If they are arranged to show train on line, they also show danger to the train.

The signal cabins in large stations serve as block posts for the main lines. The arrival of trains from different tracks on to the different groups or tracks, is definitely determined by the man in charge of the traffic by means of special slotting appliances.

7° Paraffin oil is generally used for lighting the signal lamps.

In stations in which electric supply is available, electric lighting has been in use for several years, either by means of a system having the lamps in series, or that having them in parallel, together with optical and audible indication for each lamp or series of lamps in case of one or more being extinguished.

8° Trials have been made and results, so far favourable, have been obtained, of light signals of medium and long range of visibility of the Westinghouse Brake & Saxby Signal Company's system. It has been found advisable to adopt the long range of visibility signals with two double filament lamps, one serving as stand-by and lighting automatically when the regular lamp becomes extinguished.

9° In the case of main lines, it is thought necessary to introduce modifications in the present signalling system in order to be able to adopt the three-position signal.

(See the investigations of Mr. Zanotta, the engineer, relating to this subject and also the notes given in chapter V.)

In applying these different signalling systems to the case of a junction near a station and close to a block post on the main line, the following arrangements will be adopted, for comparison with which we have shown the English signalling system alongside, and for further information have also shown the arrangements that were proposed in 1917 by the Italian engineers.

In figure 33, we have shown the arms hatched that occupy more than two positions.

Final summary.

From the examination of the signalling systems adopted by the three Administrations of the Belgian, Netherlands, and Italian Railways, some definite results can be obtained regarding certain questions, and suggestions regarding certain other questions, which it will be very useful to submit for the consideration of the Congress :

1° It is generally recognised that for the future, semaphore signalling with home and distant arms should be generally adopted because of the advantages that it presents over other signalling systems; on main lines having many curves and run over by trains at high speed, it is necessary that these signals should show the following three readings :

For the home signal :

Absolute stop;

Proceed at reduced speed;

Proceed at normal speed;

And for the distant signal :

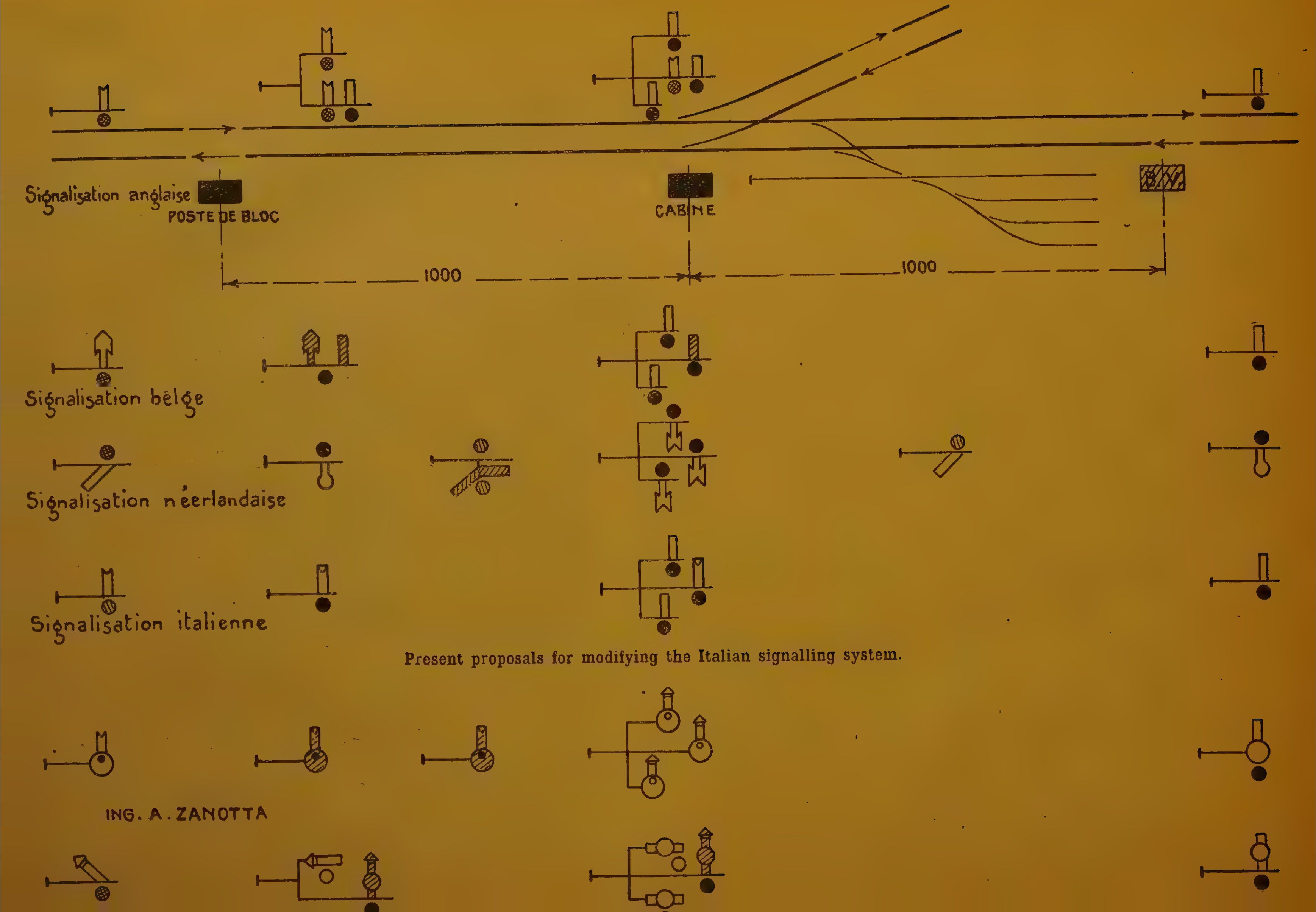
Proceed, next signal at danger;

Proceed, next signal at proceed at reduced speed;

Proceed, next signal at proceed at normal speed.

These readings should evidently be given by arrangements which by day and by night must be quite distinct, clear, and simple, so as to avoid any doubt and error in their interpretation.

The indications should give complete safety for the working of the train service at the permitted speeds for the conditions given by the plan and section of the line. It is, moreover, necessary to make a definite distinction between the signals on express lines and those on slow



Present proposals for modifying the Italian signalling system.

Translation of the French terms of the figure 33.

Signalisation anglaise = English signals. — Signalisation belge. = Belgian signals. — Signalisation néerlandaise = Dutch signals. — Signalisation italienne = Italian signals. — Ing. A. Zanotta = Proposal of Mr. Zanotta, Engineer. — Ing. C. De Benedetti = Proposal of Mr. C. De Benedetti, Engineer.

lines where these lines are parallel or intersect.

These indications can be given by arms of definite shapes, making definite angles with the post, or set horizontally and vertically on brackets with separate coloured lights or combined lights for the same purposes.

Differences arise in the application of these methods.

2° With regard to the visibility in relation to the signal post, and to enable the signals to be differentiated from each other, the best positions that a semaphore arm can occupy are undoubtedly : the horizontal position, the position inclined at 45° downwards, and the position inclined at 45° upwards.

The movement of the arm from inclined upwards to the position of inclined downwards passing through the horizontal position (danger or indication that the next signal is at danger) has no real importance in practice : any intermediate position in the lower sector, or above the horizontal, is in favour of safety.

For subsidiary conditions, the arrangements : horizontal, inclined upwards at 45°, and vertically upwards, but clear of the post, are good solutions.

At night, the most suitable lights corresponding to the three positions of the arm are : red (stop), yellow (reduce speed), green (line clear); this selection is not only based on considerations of visibility and distinctiveness of the lights, but also on their traditional recognised meanings.

It is necessary to avoid the risk of a warning signal being taken for a stop signal and *vice versa.*

The arrangement adopted by the Dutch railways, giving the distant signal arm two positions : inclined downwards, and inclined upwards, is to be recommended from this point of view.

The vertical position for the arm alongside the post, and the white light should only show a signal that does not affect the route under consideration.

3° On short sections, when it is necessary to combine the home signal arm and the distant signal of the next home signal, is it preferable to arrange the two arms one above the oher on the same post (English system), or to carry them on the same spindle (Italian system), or to replace the group of two signal arms by a single stop arm (the American system adopted by the Belgian State Railway).

The normal succession of distant signal by home signal evidently assists the driver in determining the dangerous points of the route, and consequently where to look for the signals.

Hence the English system is generally preferable.

On this subject, it may be observed that it has not always the same effectiveness or clearness; for example, on electric lines, or in tunnels, where it is necessary to use signal arms or lights arranged above each other, the English system may lead to wrong readings.

The Italian system, however, modified so as to render the coexistence of the two arms more visible, and without reducing the lights, appears to be that which lends itself best to the object in view.

The arrangement proposed by Mr. Zanotta, the engineer of the Italian Railways, to utilise one arm or the other for the necessary indications, by eliminating one or the other of the two coupled arms, is in our opinion rather artificial and difficult to understand.

The grouping that we have shown, and which is doubtless capable of improvement, comprises a graduated and logical succession of lamps : in fact, from green one goes to red, passing through the combined yellow and green to the two yellow lamps.

The sequence of colours having a natural value, is the best of guides for graduating the speed. It is, moreover, only right to appreciate that the substitution of a single arm or two arms effects a simplification in operation, a reduction in the cost of installation, and also of maintenance.

But so far as the signalling itself is concerned, if there is a real advantage in distinguishing the two arms, is not the extra expense worth while?

4° The English system for protecting junctions is doubtless the most nearly perfect, and makes it practically impossible to mistake the road to be taken. Actually, the Italian system, in which the junction signal is preceded with a distant signal having one arm only, capable of occupying two positions, horizontal and inclined downwards, often leads to a driver being misled as to the track which is to be taken, and may lead to serious consequences.

The new Belgian arrangement, giving three positions to the semaphore arm, represents a remarkable improvement on the Italian system.

The same thing may be said for the Dutch arrangement (*waarschuwing*) with two distant arms which give three indications. Both of these arrangements are, however, incomplete in the case of a three-direction junction.

5° The signal with several arms presents the anomaly of the simultaneous existence of one arm at line clear and the others at danger, and a green light with other, red, lights.

We think it opportune to eliminate this anomaly even though a complication in the manipulation of the arms should result. It would also have the advantage that, without exception, the horizontal arm and the red light would have a definite meaning of stop.

6° It is not necessary that the block signal (home and distant) should have different forms from the ordinary semaphore signals.

7° In large stations, it is advisable to adopt bracket semaphores to control the arrival of trains on the various groups of tracks and on the tracks themselves, by completing, in some cases, the indications given by the arms, by numbers (figures or letters), as has been adopted on the Belgian State Railways.

The distant signal, also of bracket form, relating to the home signal, should not be fitted with arms relating to arrival on the groups of goods sidings.

In the absence of a distant signal, the driver must act as though he expects to find the home signal at danger.

In practice, semaphores of small dimensions and two positions, known as « arrival and departure track indicators », adopted by the Italian Railways, also give good results.

8° To ensure regularity and safety for the traffic, it is advisable to adopt arms taking three positions (violet, yellow, and green lights) of reduced size for controlling shunting operations, a system adopted in Belgium.

It is also advisable to adopt special ground disks capable of taking two positions (red and green), in use in Italy, as shunting signals interlocked with the points and the ordinary signals.

9° As the various cabins that follow each other in a station are generally interlocked with each other, as if they formed block posts for the main lines, it is necessary that they should be controlled by the employee in charge of the traffic in such manner that he can give effectively the slotting instructions for the arrival of trains on the different groups of tracks and on the platform tracks.

10° In the most important stations : having heavy traffic, where shunting operations are of frequent occurrence, it is advisable to arrange track circuits showing the occupation of tracks by the trains.

11° The indication of the approach to distant signals by means of white indicator boards on the Belgian system, should be generally adopted in the open, as a means of replacing audible signals, (for signals, gongs, etc.) when the boards, in case of atmospheric disturbance, can be sufficiently lighted by the headlights of a locomotive, and the driver drives his engine from the same side as that on which the signals are placed.

In tunnels where steam traction is used, the use of audible signals is necessary.

12° The electric lighting of signals should be gradually extended, and preference given to the system in which the lamps are arranged in parallel, comprising one lamp normally lighted, and the other as stand-by for each principal signal, with an indicator showing when each lamp is extinguished, and with automatic lighting of the stand-by lamp.

13° It is desirable to continue the trials of colour light signals with a view to obtaining the necessary information for arriving at a decision regarding their adoption.

APPENDICES.

Appendix A.

Electro-mechanical arrangement for checking the working of electric lamps at a distance and for the automatic insertion into circuit of stand-by lamps in case of ordinary lamps going out, designed by M. Mario Fiachetti, engineer, of the Italian State Railways

The drawing given in figure 34 represents diagrammatically a scheme of the new arrangement.

This arrangement consists of an electro magnet with two windings E^1E^2 on the core N, and with a switch M.

The winding E^1 is inserted in the circuit of the local lamp L.

The winding E^2 in inserted in the outer circuit of the two lamps at a distance, A and B, to be checked, the one being the stand-by for the other.

The electro-magnet consists of a non-polarised armature R, which is only attracted in case of failure. The switch M, in the circuit of the two lamps to be checked, can occupy two positions.

In the position shown in the drawing, contact 6 is connected to contact 7, and contact 8 is connected to contact 9.

In the other position, contact 6 is connected to contact 9 and contact 7 to contact 8.

The switch is hand-operated. When the armature R is attracted by the electro-magnet, it turns about the centre O, and, by means of contact C, puts into circuit the lamp A or the lamp B, according to the position of the switch M.

It also, by means of the contact C^1 puts into circuit the audible or optical warning K.

The switch T enables the lighting of the lamps A and B, situated at a distance, to be controlled, and also to put into circuit simultaneously the control and automatic lighting apparatus arranged near the switchboard.

The new arrangement consequently meets the following conditions:

1° The electro-magnet E^1E^2NS is not excited, that is to say, it does not attract the armature R, so long as the two windings produce equal and opposite magnetic fluxes. In this case, the closing of the switch T on the supply line, makes the following circuits alive:

I. — Local lamp circuit L = 1-2-4-E^1 (in the direction NS)-L-5-11.

II. — Distant lamp circuit A to be checked: 1-2-4-E^2 (in the direction SN)-6-7-A-10-5-11.

2° The electro-magnet causes the attraction of the armature R when a change of equilibrium is produced between the two windings E^1E^2, and causes the automatic lighting of the stand-by lamp B, by closing the following circuits:

III. — Distant stand-by lamp circuit B=1-2-3-C-8-9-B-10-5-11.

IV. — Audible warning circuit K=1-2-3-C'-K-5-11.

The indication is given when:

a) The distant lamp A, to be checked, is out;

b) The local lamp L is out;

c) There is a short circuit or leakage in the circuits;

d) The current is diminished or is interrupted in the leads.

3° With alternating current, when all is in order, the electro-magnet does not act on its armature, and therefore produces neither drop of voltage due to induction, nor disturbance in case of vibration of the armature.

4° The checking acts equally in both senses. Actually:

a) The electro-magnet shows the disturbances that are produced either in the circuit of the lamps at a distance, or in the circuit of the local lamp;

b) The switch M enables one of the lamps A or B to be substituted for the other in such manner that the normal lamp can be made the stand-by and *vice versa.*

5° The condition of equilibrium is restored automatically, and the electro-magnet leaves the armature R when the disturbing cause has ceased to exist.

6° It is not necessary to arrange recording apparatus or special adjustable resistances, because equilibrium can be obtained for the system by the use of lamps of the same kind, and same current consumption, for the local and distant lamps.

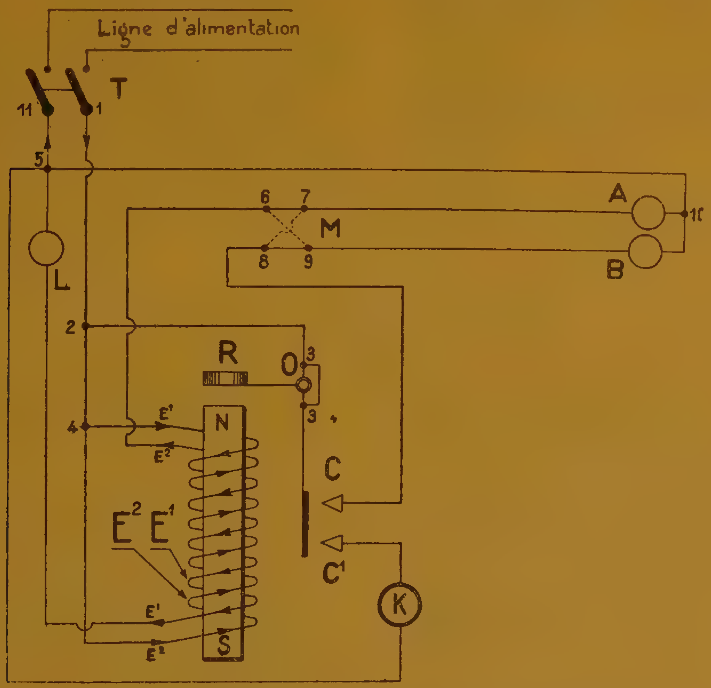


Fig. 34. — Indicator circuits for lamps at a distance.

Translation of French terms : Ligne d'alimentation = Electric supply leads.

The local lamp L also serves to show that the current is on the line.

7° The circuits of the local lamp L and of the distant lamps A and B are completely independent, so that any disturbance in the one cannot cause a disturbance in the other.

8° The lighting of the stand-by lamp, in case the normal lamp should go out: is effected by turning the switch M.

Actually, if the lamp A should go out through disturbance, the circuits III and IV given under 2° are made.

By turning the switch M, so as to put the contact 6 in communication with 9 and the contact 7 with 8, if the stand-by lamp B is regularly alight, the condition of equilibrium is produced because the current flows through the circuit I of the local lamp L as in 1°, and the current lighting the lamp flows through the following circuit:

V. — The circuit of the distant lamp B to be checked: =1-2-4E^2 (in the direction SN)-6-9-B-10-5-11.

9° The supply current to the lamps requiring to be checked and that to the local lamp of the apparatus on the switch-board, is effected by means of the switch T.

10° The checking is permanent, that is to say, it works through the whole period of lighting of the distant lamps.

11° The apparatus is not affected by variations in voltage or in frequency of the current supply.

12° The apparatus can serve to check simultaneously several lamps a distance that are arranged in parallel, if the ratio between the number of turn of the two windings E^1E^2 of the electro-magnet is suitably adjusted, or if the consumption of the local lamp L is modified.

For example, when, instead of two lamps A and B, two groups of five lamps in parallel are used, the winding E^2 will carry a current five times as great as that in the winding E^1. In this case, in order to obtain equilibrium it is necessary that the number of turns in the winding E^2 should be to that of the winding E^1 as 1 is to 5.

Appendix B.

Results obtained during trials of the luminous coloured long-range signals of the « Westinghouse » type.

On the 4 of June 1923, trials were made at Turin (shunting) station of two new luminous coloured *long-range signals of the « Westinghouse » type;* these were arranged in advance of the first-class single-arm semaphores and of the distant signal covering the Turin (shunting) station.

The luminous signals operated in such manner as to repeat the indications given by the first-class semaphores and the distant signal, were considered as auxiliary signals to these semaphores, which were retained in service.

Each signal consists of a box divided into two compartments: the upper compartment for showing « train on line » (red light), or « notice of track occupied » (yellow light); the lower compartment for showing « line clear » (green light).

Each compartment is fitted an external coloured lens (of the Fresnel type) 21 cm. (8 1/4 inches) in diameter, and an internal parabolic mirror. Between the two lenses are two incandescent metallic filament lamps: a main lamp at the focus of the Fresnel lens, and the other (the secondary lamp) at the focus of the mirror.

Each signal is carried on a post (Mannesmann tube), at 1 m. 80 (6 feet) from the nearer rail, and at 4 m. (13 ft. 1 1/2 in.) above the rail level.

The signals are supplied with current at 120 volts, 48 periods.

In the distant signal (yellow-green), the two lamps in each compartment are connected in parallel to the secondary circuit of a small transformer, are lighted simultaneously, and have an illuminating power totalling about 50 candles.

The lamp at the focus of the mirror is a 25-watt, 50-volt, long-filament lamp, and that at the focus of the lens is a 25-watt, 6-volt, short-filament lamp. In the case of the secondary lamp going out, the intensity of the light shown by the signal hardly changes. As the result of the extinction of the main lamp, the visibility of the signal is reduced by more than one-half, because the position of the secondary lamp not being at the focus of the lens, a greater dispersion of the rays of light is caused.

In the first-class signal (red-green) the small transformer is not used, and the two lamps in each compartment are supplied direct with current at 12 volts, and at less than their nominal voltage. They have the following characteristics:

50-watt, 125-volts, 50 candles, special short-filament lamps.

Normally, only one of the two lamps is lighted, while the other serves as a stand-by and is only lighted when the first goes out.

The visibility of the home signal is appreciably greater than that of the distant signal, because the short filament of the only lamp that is lighted is at the focus of the lens.

The supply circuit to the distant-signal lamp comprises a switch attached to the arm of the distant semaphore, in such manner that when the arm stands at line clear, the local circuit of a relay switch puts the green light into circuit and cuts out the red light. This signal is not fitted with an indicator for checking the lighting at the switchboard in the signal cabin.

The supply to the two lamps (red-green) of the first-class signal, is effected by means of a hand-operated switch worked by the pointsman.

The variation in the indication of the signal *from red to green*, depends on the position of the signal arm lever, and on the actual position of the arm itself.

The check (optical and audible) on this signal and on the lighting of the lamps, is obtained at the cabin by means of a relay with double winding and a local lamp of 10 candle power.

In case a lamp should go out, the relay puts the stand-by lamp into circuit and checks its working.

During the day, even with bright sunlight, the signals are clearly visible at a distance of 400 m. (440 yards).

In case of thick fog, the luminous signals are easily visible at a distance of 150 m. (165 yards). At night, under normal atmospheric conditions, the signals are visible at a distance of 800 m. (880 yards); and at night, with thick fog, they are still visible at a distance of 200 m. (220 yards).

These results correspond to the normal luminous intensity of about 50 candles.

In one year three 50-volt lamps were replaced on the distant signal, one owing to defective construction (coming apart from connecting piece) and the two others through burnt-out filaments. Two 6-volt lamps were, moreover, replaced owing to diminution in illuminating power. Finally, three lamps were replaced on the home signal: one because the filament was burnt out, and the two others because of diminution in illuminating power.

A regular check was kept to detect these irregularities.

The visibility of the luminous signal with coloured lights is greater than that of the semaphore, particularly at night, so that under the worst atmospheric conditions, the luminous signal is always visible at more than the regulation distance of 100 m. (110 yards).

During a working period of about 5 000 hours' lighting of one signal, the consumption of current was about 250 kw.-hours, and, at the cost of 0.20 lire (the rate in force), amounted to a daily expenditure of 0.25 lire, to which must be added the average cost per day of 0.30 lire (0.20 lire for the first-class signal, and 0.40 lire for the distant signal), for the replacements of lamps at the mean cost of 10 lire each.

A paraffin lamp for an ordinary semaphore consumes about 0.20 litres (0.35 pint) of paraffin oil per night, that is, at a cost of 2 lire per litre, a total cost of 0.40 lire.

To this cost must be added the cost of repairs and of substitution of the lamps and the lanterns, as well as varnishing, lubrication, maintenance of wires, poles, pulleys, batteries, and accessory apparatus, the cost of which is greater than that of the oil for lighting.

Apart from the cost of installation, the cost of maintenance of the luminous signals, without counting the daily expenditure on the staff responsible for the lighting, is obviously less than that of the semaphore.

Appendix C.

Results of trials of luminous coloured, medium-range signals of the « Westinghouse » type, in Lodi station

In December 1923, two signals with coloured lights were put into service at Lodi station; these signals repeated the position of a first-class home signal on the Piacenza side, having two arms arranged one above the other (and the distant arm combined with the lower arm), and of the corresponding distant signal.

These signals are operated by switches carried directly on the arms which they repeat.

Each light is given by an optical arrangement consisting of a Fresnel lens, 160 mm. (6 5/16 inches) diameter, coloured red, yellow, or green. At the focus of the lens, a 30-watt, 30-volt lamp of the concentric filament type is placed. Behind this lamp is placed another lamp of 30 to 50 watts also of 30 volts.

Both lamps are lighted together. They are fixed to a lamp-holder which can be adjusted vertically so as to bring the filament of the front lamp into the focus of the lens.

The lamps are fitted for screw-socket connection and with concentric filament, divided into two parallel sections, so that if one or the other portion of the filament should break, the other part remains alight, and prevents the total extinction of the signal.

The lights are not checked by indicators.

When the lamps are set to the focus of the lenses, the visibility during the daytime and normal atmospheric conditions is from about 400 to 500 m. (440 to 550 yards).

In day time, in bright sunlight, the lights are visible at about 200 m. (220 yards).

At night, under normal atmospheric conditions, the signals are visible at 800 m. (880 yards).

In foggy weather, these distances were never found to fall below 100 m., and kept a mean value of about 150 m. (165 yards) by day, and more by night.

These results hold when the lamp is in the focus of the lens and the whole filament is intact. If the filament is reduced to one-half, the illumination diminishes, but not greatly, and it is still possible to obtain sufficient illumination in case of fog.

These results are considerably altered when the lamp is not set exactly in the focus of the lens. This point is, therefore, of the greatest importance.

Appendix D.

Details of construction and working of a new semaphore (signalling scheme devised by Mr. Zanotta, engineer).

Mechanism for double-wire working.

The operating of a semaphore arm of a home signal or distant signal, or of each of these arms coupled together, is effected by a double-wire connecting the circular sector on the operating lever with a grooved pulley (1) carried on a bracket attached to the semaphore post. A bell-crank lever (2-3) — figure 35 — turning about the pin (4) is attached to the pulley bracket.

The arm (2) carries a roller (5), guided by a camgroove in the pulley.

The arm (3) is connected at its end to the operating rod of the semaphore arm.

The cam-groove for the travel (*f-g*) of about 180°, remains at constant radius (*a'*), whereas, the complementary half revolution is divided into four successive sectors of varying radius (*d*-*a*-*b*-*c*) made continuous with each other. The radii (*a*/) and (*a*) are equal to each other.

These sectors are used to give the bell-crank (2-3) three positions corresponding to those required in the signal-arm for passing from the normal horizontal position to that of inclined downwards, or to that of vertically downwards, or finally to that of inclined upwards.

In the normal danger-position (fig. 36, A) the roller (5) is in the part of the sector of radius (*a*).

When the pulley turns contra-clockwise, it forces the roller (5) of the bell-crank (2-3), to move from the sector of radius (*a*) to that of radius (*b*).

Consequently, the bell-crank (2-3) turns to the right, and moves the rod (7) upwards.

The arms takes the position of inclined at 45° downwards (fig. 37).

The pulley continuing to turn in the same direction, the roller (5) passes from the sector of radius (*b*) to that of radius (*c*). The bell-crank (2-3) sets the arm to a position vertically downwards (figs. 37 and 38, B and E).

When the arm is in its normal horizontal position, by turning the pulley (1) in the opposite direction, that is to say clockwise, the roller (5) runs from the sector of radius (*a*) to that of the radius (*d*), the rod (7) is lowered and sets the arm to the position inclined at 45° upwards (fig. 38, D).

For signals in tunnels, the operation of the discs is effected in the same way as that of the semaphores, by means of a pulley having a cam-groove (1) carried on a bracket attached to the post of the disc, the bell-crank with two arms (2-3) and the rod (7) attached to the disc.

The discs being themselves fitted with the same coloured glasses and the same holes as the semaphores, consequently give the same readings as the semaphores themselves.

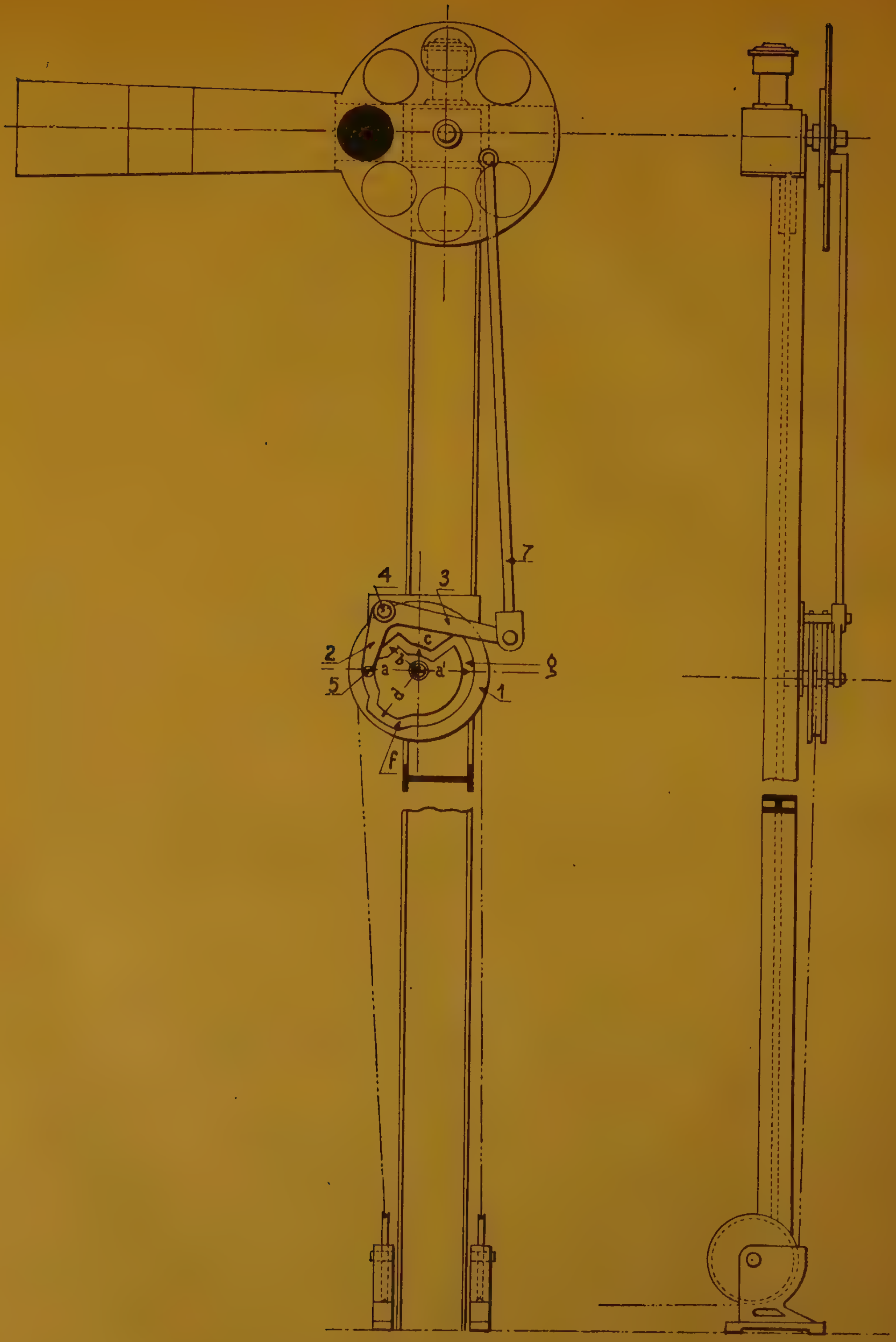
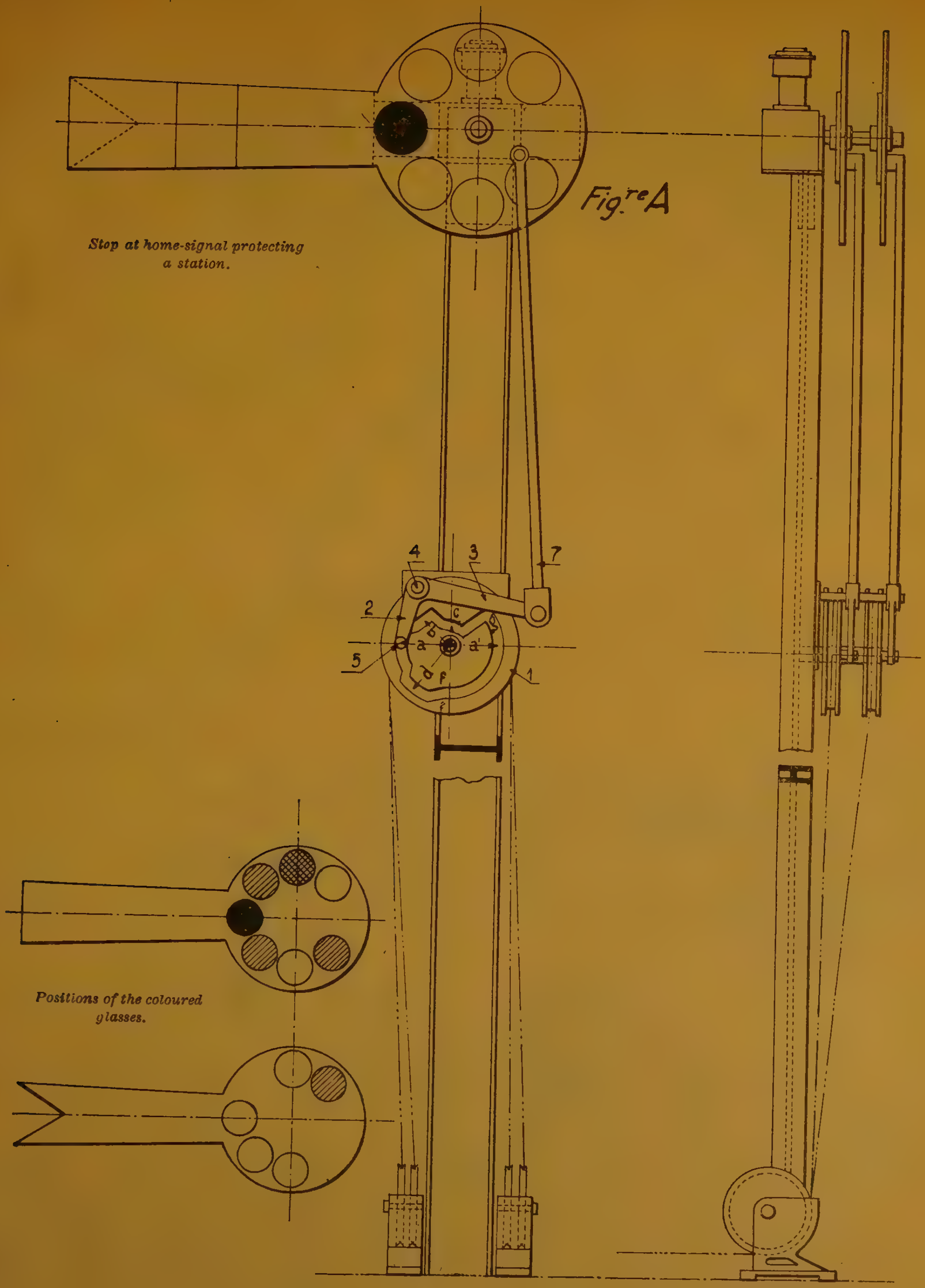


Fig. 35. — Stop (home) semaphore.



Stop at home-signal protecting a station.

Positions of the coloured glasses.

Fig. 36. — Semaphore with two arms coupled (fig. A).

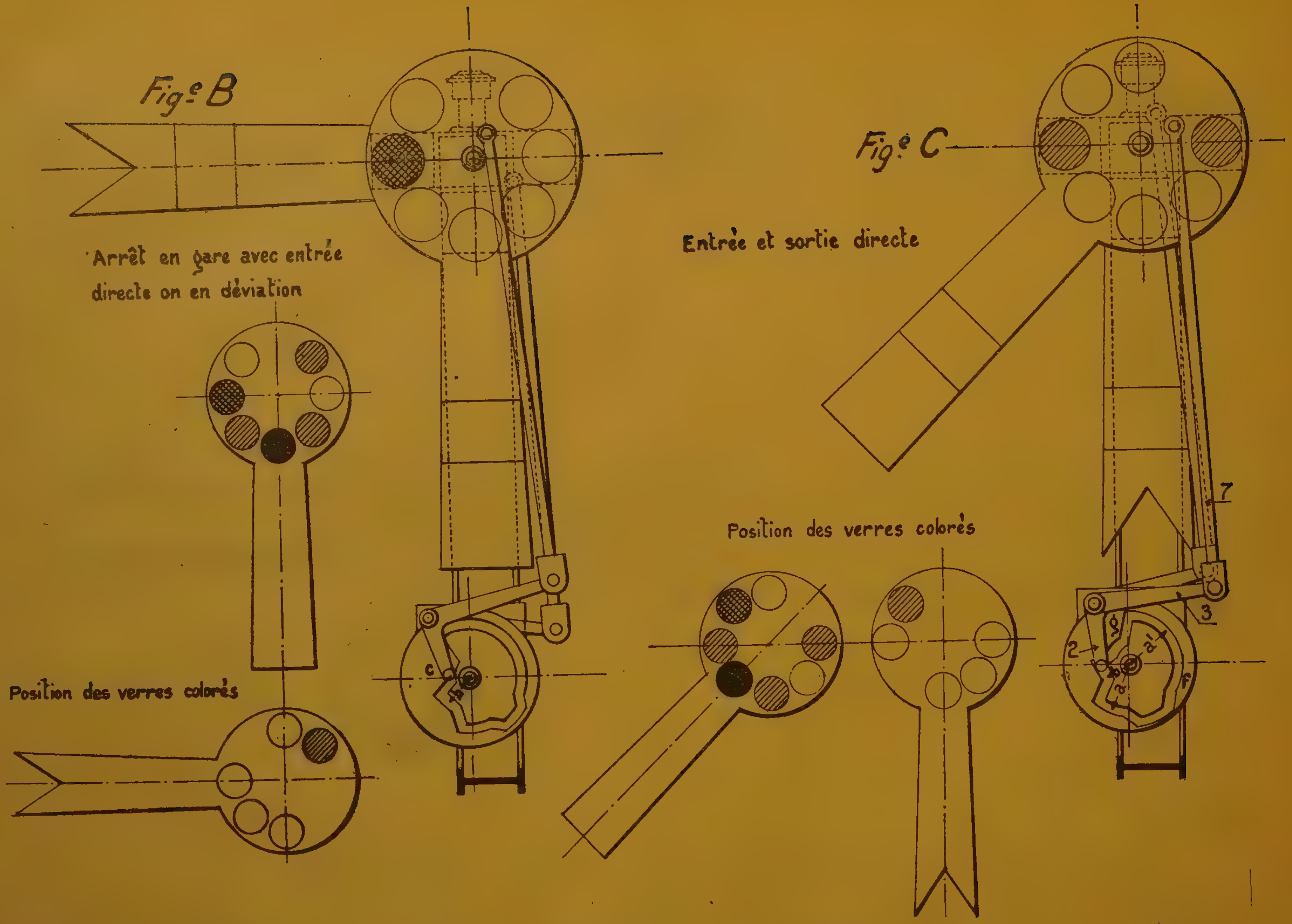

Figᵉ B
Arrêt en gare avec entrée directe on en déviation
Position des verres colorés
c
Figᵉ C
Entrée et sortie directe
Position des verres colorés
7
3
2
a
a'
b
f

Fig 37. — Semaphore with two arms coupled.

Translation of French terms Arrêt en gare avec entrée directe ou en déviation = Stop at station arriving from branch or main line. — Position des verres colorés = Position of the coloured glasses. — Entrée et sortie directe = Arrival and departure by main line.

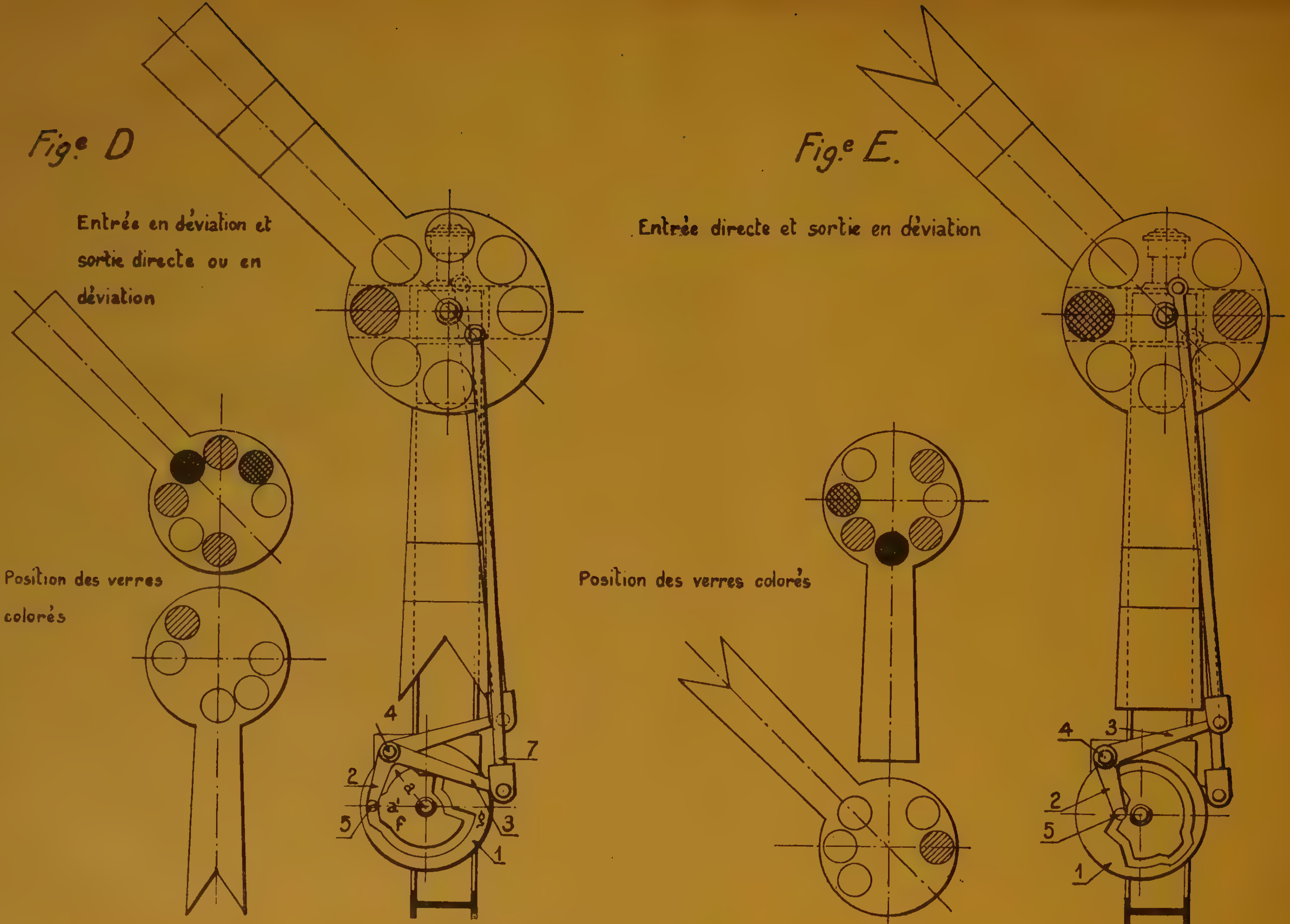

Figᵉ D
Entrée en déviation et sortie directe ou en déviation
Position des verres colorés
4
2
5
7
3
1
a
a'
f
Figᵉ E.
Entrée directe et sortie en déviation
Position des verres colorés
4
3
2
5
1

Fig. 38. — Semaphore with two arms coupled.

Translation of French terms : Entrée en déviation et sortie directe ou en déviation = Arrival by branch and departure by main or branch. — Position des verres colorés = Position of the coloured glasses. — Entrée directe et sortie en déviation = Arrival by main line and departure by branch.

[385 .581]

REPORT No. 1

(Switzerland, Italy, Spain and Portugal)

ON THE QUESTION OF THE EIGHT HOUR DAY (ARTICLE X OF THE QUESTIONNAIRE FOR THE TENTH SESSION OF THE INTERNATIONAL RAILWAY CONGRESS ASSOCIATION), (1)

By Luigi VELANI,
ASSISTANT GENERAL MANAGER OF THE ITALIAN STATE RAILWAYS (2).

SUMMARY.

I. — Introduction.

II. — Development of the regulations relating to working hours on the Italian railways.

III. — Comparison between the various States.

- 1. — *Rules concerning employees of various categories :*
  - *a*) Footplate and train staff;
  - *b*) Station and shed staff;
  - *c*) Permanent way staff;
  - *d*) Workshop and stores staff;
  - *e*) Rules concerning employees of all categories.
- 2. — *General rules.*
- 3. — *General considerations.*

IV. — Note on the methods of applying the eight hour day.

V. — Summary.

VI. — Appendices : 1. — *Detailed questionnaire.*

- 2. — *Development of the rules dealing with working hours on the Italian Railways.*
- 3. — *Number of staff on the Italian State Railways.*
- 4. — *Decree of the Lieutenant-General of the kingdom, 8 June 1919, No. 912.*
- 5. — *Royal decree of the 22 July 1923, No. 1631.*
- 6. — *Royal decree of the 19 October 1925, No. 2328.*
- 7. — *Swiss Federal law.*

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(1) This question is worded as follows : « The eight-hour day on the railways ».
(2) Translated from the French.

I. — Introduction.

The eight hour day, upon which question we have the honour to act as reporter, is an ideal which beyond all others, especially during the years which followed the war, has always greatly appealed to the mass of workers, including those employed on railways. The eight hour day, moreover, forms one of the first and most important demands of international trade unionism; thus during the closing years of the last century, and at short intervals, we have had a succession of strikes, not only to obtain increases in pay, but also better working conditions.

Hence, as far as railways are concerned, the regulation of working hours has been complicated by the successive reduction in the length of the working day and by the necessity arising therefrom of organising the departments so as to obtain a sufficient output from the men employed.

The question of working hours and conditions was examined at the seventh meeting of the International Railway Congress (Washington, May 1905), but the question of the eight hour day in its complete application was not at that time discussed.

The report we have to draw up is limited to a few countries : Italy, Switzerland, Spain and Portugal; however, to obtain a greater uniformity in dealing with the subject, we have thought it well to discuss the matter in the first place with other reporters dealing with the same question, so that the necessary information might be collected by means of questionnaires drawn up on the same general principles. Our questionnaire (*see* appendix I) has been sent to forty-three railway administrations in the countries mentioned above; seventeen only have replied, and seven of these have sent in no information. We have therefore only the information supplied by ten administrations, fortunately we have been able to obtain the information from the principal railways in the countries mentioned, and this will be found in the report.

As regards Portugal, we have only received information from the Portuguese Railway Company, which is the second railway in the country with a length of 670 miles.

It was from 1919 to 1921, at the end of the great war, that the eight hour day was adopted almost generally throughout Europe.

Among the four countries with which the report deals, Italy alone adopted the reform on such broad lines and carried out all the heavy requirements to such a degree that it was found necessary to subsequently modify the way in which it was applied. Therefore we think it well to examine, in the first chapter, the change which took place in the adoption of the principles of the eight hour day in Italy, especially on the State Railways, which represented the largest Italian administration, and also to submit the inferences which may be drawn therefrom, and to compare these later with the regulations adopted at the present time in the various countries from which a summary of a general nature may be drawn.

For these two investigations, in the analyses which have to be made separately for employees of different categories, we will commence with the footplate and train staff, which branch of the service, on account of its varying conditions, is the most difficult for which to draw up uniform rules.

II. — Development of the regulations relating to working hours on the Italian Railways.

In Italy, the first legal regulations dealing with working hours on railways were promulgated by Royal Decree No. 264 of the 10 June 1900, but this only dealt with the staff concerned in the safe working of the railway. As may be seen from table 2 (appendix), this dealt with the question of the maximum working hours and the minimum time for rest, and imposed so few restrictions that the greatest use could be made of the staff.

The rules were amended somewhat laterly (Royal Decree No. 477 of the 1st November 1902), but the modifications were, broadly speaking, unimportant.

This state of affairs remained after the railways were taken over by direct State Administration in 1911, in spite of a number of agitations which were mainly of an economic nature. After 1911, the institution of representatives of the staff by the Act of the 13 April 1911, No. 310, gave rise to a series of demands of all kinds on the part of the staff, and of these a considerable number aimed at obtaining better working conditions. In consequence, gradual reductions in the length of the working day were granted with longer hours of rest and greater restrictions on the hours worked, until in 1914 the promulgation of the new rules (Royal Decree No. 993 of the 20 August 1914) while appreciably improving the conditions previously in force, did not, however, allow the administration to obtain a sufficient output from its employees. By this Decree, the principal regulations, which are summarised in table 2 (appendix), and which refers only to the staff concerned with the safe working of the line, are granted a considerable reduction in the average length of working hours, both as regards *period of working* and of the work performed in this period, an increase in the ordinary hours of rest and the introduction of periodic holidays; finally this Decree considerably increases the hours which are reckoned as *night work*.

As regards other categories, there had never been, strictly speaking, any regulations as regards working hours. A certain number of rules were established in this respect by the Regulations for the staff, which merely stipulated that the maximum working hours should be twelve and the minimum period of rest eight hours or seven hours in accordance with the distance from where the man lived.

In principle, however, for employees whose work is continuous during the hours they are on duty, this was limited to ten hours, except for the controlling and administrative staff in the offices, for whom the working hours have been as a rule seven hours since 1905, and before this in some cases seven hours and in other cases seven and a half hours. From 1912 to 1914, days of rest were allowed every fifteen days, except for office staff, who in the latter years of the last century were allowed every alternate Sunday off duty.

During the period of the war and up to 1919, the rules in force in 1914 remained unchanged. In 1919 the Government conceded, with certain important economic alterations, the eight hour day and a weekly day of rest (Decree of the Lieutenant General of the Kingdom, No. 912, of the 8 June 1919 (appendix IV).

By virtue of this Decree, however, the eight hour day was not applied universally, but only to employees of certain categories whose work was continuous or arduous.

As regards employees of other categories, comprising about 21 % of the whole, powers were given to the Minister of Transport to make suitable reductions in the working hours, and in this way were established working days of nine, ten or eleven hours in accordance with the nature of the work performed.

However in practice, as the result of agreements with the trade unions, the eight hour day (extended in the sense of eight hours on duty and not eight hours of effective work) was extended to employees of all categories without distinction, including permanent way watchmen.

The following were the regulations adopted for employees of the various categories :

A) *Footplate and train staff :*

1. — Average length of working hours : forty-eight per week;

2. — Maximum interval between two ordinary periods of rest (period at work) : twelve hours (eleven hours for drivers and firemen of express and similar trains);

3. — Maximum amount of effective work between two ordinary periods of rest : eight hours (seven for drivers and firemen of express and similar trains);

4. — Method of calculating :

a) when present at the shed : at full rate when at home shed and at half rate when lodging out;
b) when travelling as passengers : at full rate;

5. — Additional time worked :

a) before the departure or after the arrival of trains; according to circumstances for footplate staff : forty-five minutes for passenger trains, sixty minutes for freight trains, for train staff;
b) for each journey as passengers : fifteen minutes before and fifteen minutes after;

6. — Minimum length of ordinary period of rest :

a) at home : sixteen hours;
b) when lodging out : ten hours for footplate staff and seven for train staff;

7. — Periodical days of rest :

a) number per year and maximum length : 52 periods of forty hours (32 for staff employed in shunting);
b) maximum interval between two successive days off : eight days;

8. — Night working :

a) hours reckoned as night duty : between mid-night and 5.0 a.m.;
b) maximum number of nights worked consecutively : 4;

9. — Maximum period away from home : 28 hours;

10. — Maximum mileage between two ordinary periods of rest : 155 miles for footplate staff, 125 miles for train staff;

11. — Length of interval between arrival and departure by the same train or by another train, counted as working hours : two hours.

12. — How are the working hours calculated : in accordance with actual time of arrival.

On the one hand the limits of the working period, the maximum hours worked daily, the number of consecutive nights on night working, the length of the periods on duty absent from home and the mileage run in the working period, and on the other hand, the excessive extension of the periods of rest both daily and periodical, the large periods of idle time counted as working time rendered it impossible to obtain eight hours of effective work in any case; while, moreover, when these regulations were first applied, the output of the footplate and train staff in general did not amount to, on the average, more than four hours effective work on the trains.

It was impossible to work in forty-eight hours per week with the maximum working period between rests which was fixed at eight hours and with the period of rest of sixteen hours : the coexistence of the former and latter of these conditions did not allow the average period per day to approach the limit of eight hours, while this remained as a maximum which was more than double the average working day.

This reduction in the effective working hours would have been less serious if one had pooled the engines, that is to say, any set of men might take out any locomotive, but in this country neither the staff nor the equipment were prepared for so radical a change, so that this system had to be abandoned, although it would have been very desirable.

It should be remembered that before the adoption of the eight hour day that the footplate staff worked on an average ten hours and the train staff eleven hours per day, while the working hours might extend to seventeen hours and the effective work per day might be twelve and forteen hours respectively, and in some cases even to one hour more, so that the minimum hours of rest were only ten and nine hours at home, and seven hours when lodging out, that there were only 24 and 18 holidays of thirty-four hours per year respectively, that time waiting as spare men was paid at a lower rate, and that the short intervals of rest which are reckoned at working hours were one and a half hours and one hour only and that none of the new restrictions formerly existed, and we shall readily understand what has been the effect of the application of the eight hour principle in the form in which it was originally applied.

It is sufficient to say that the footplate and train staff, which had been in the year 1914-15, 0.35 of a unit per 1 000 train-miles, increased in the year 1920-21, after the complete application of the eight hour day law, to 0.66, that is to say, an increase of 86 %.

The increase of expense was still greater, seeing that is was also affected by the considerable allowances given to the staff to meet the increase in the cost of living due to a depreciated value of the currency.

Other causes contributed, it is true, to this increase in the number of staff employed, but the considerable number of new employees taken on to meet the needs arising from the application of the eight hour day appreciably reduced the standard of skill, and therefore reduced the output of the staff. A serious lack of discipline and the granting of additional pay removed all encouragement to work. The very frequent relief of train crews who had completed their full working day before finishing the journey owing to trains running late, the difficulty in obtaining a better output from the staff by reason of having to deal with local committees, the demands on the part of the staff to return each day to their homes, which gave rise to an excessive and unjustifiable number of journeys as passengers, were also causes which contributed in a greater or lesser degree to the increase in the number of the staff.

However, even allowing for all these

causes, the increase in the staff due to the application of the eight hour day, which was brought into force without taking any consideration of the serious consequences which would result therefrom as regards industry, should be considered as excessive and absolutely out of proportion with the benefit which the staff have obtained by the reduction of the working hours. In addition to this, the insufficient hours of work and the reluctance of the staff to be absent from home compelled the Administration to provide a number of secondary depots, in many cases at places without any convenience or without any lodgings, keeping there for long periods men on duty, which led to a very considerable expense. The running of the trains also had its effect on the above stated circumstances, as late running of trains, both passenger and freight, became very much a matter of course, depending on the state of repair of the rolling stock and on the quality of the fuel.

B) *For station and shed staff*, their work was arranged in the following manner :

1. — Working day : eight hours;

2. — Ordinary period of rest :

a) employees living close to the place where employed : ten hours as a minimum;

b) in other cases : ten hours as a minimum;

c) absolute minimum length of time : ten hours as a minimum;

3. — Maximum number of periods into which the working day might be divided : not fixed;

4. — Maximum idle time which may be calculated as working time : one hour;

5. — Periodical days of rest : twenty-four hours in addition to the ordinary period of rest after working, every seven days;

6. — Consecutive nights on duty : not more than seven consecutive nights, or more than twenty per month.

Before the adoption of the eight hour day, the working day was fixed in principle from ten to twelve hours per day, according to the degree of intensity or continuity of the work entailed. A working day of eight hours was only granted to staff employed on running of trains, or in shunting, which entailed arduous and continuous duty. The minimum period of rest might be as little as eight hours for station employees who reside close to their place of employment, and nine hours in other cases. Rest days were allowed every fifteen days.

On the other hand, the eight hour day was rigorously applied whatever the nature of the work, as regards continuity or arduousness. In this way eight hours were worked both by pointsmen employed in shunting in large stations, where the work is heavy and continuous, and also by shunters at a small station having a very small number of trains, and consequently with short periods of work and long periods of inactivity. Strictly speaking, it was not the principle of eight hours work which was applied, but eight hours on the companies premises, even if this time was passed in doing nothing.

In a large number of small stations it was therefore necessary to provide two men for work in which the time on duty were only a little more than eight hours.

By the application of the eight hour day, time off every fifteen days became changed into a weekly rest day. All this led to a very considerable increase in the number of staff quite out of proportion with the work done. In fact, the ratio of the number of station staff per 1 000 train-miles, which was 0.58 in 1914-15 became about 0.97 in 1920-21, that is an increase of 67 %; while the ratio for employees at engine sheds increased in the same period from 0.037 to 0.071, that is to say, about 97 %.

C) *For permanent way staff* the working hours were regulated as follows :

I. — GUARDING THE LINE.

1. — Length of working day : eight hours (especially permanent way watchmen). Unimportant level crossings are left unguarded.

2. — Minimum ordinary period of rest : ten hours at least.

3. — Periodical rest days : 52 days of twenty-four hours per year (in addition to ordinary period of rest after working).

4. — Consecutive nights on duty : ...

5. — Gatekeepers (women) : eight hours at work between sun rise and sun set. Rest as for permanent way watchmen.

II. — PERMANENT WAY MAINTENANCE.

1. — Length of working day : eight hours on the average (seven and a half hours in winter and eight and a half in summer); not including time taken in walking to work.

2. — Minimum ordinary period of rest : as for permanent way watchmen.

3. — Periodical rest days : no Sunday work, except one man, this duty being taken in turns and another day off being allowed in lieu.

Before the adoption of the eight hour day, the male staff employed in guarding the line worked for twelve hours out of the twenty-four, with minimum periods of rest of eight or nine hours, according to the distance of their work from their place of residence, or which might be as little as seven or eight hours on lines with small or intermittent traffic. Time off was granted every fourteen days. The gatekeepers (women) also work twelve hours (by day only) with ordinary periods of rest of nine hours, and time off every fourteen days.

The staff employed on maintenance worked on the average ten hours per day, and were free every other fete day.

The application of the eight hour day to the staff of this category would therefore have been particularly serious, if it had not been met by a reorganisation of the permanent way watchmen, which was carried out at the same time. By this reorganisation a staff of watchmen was formed by making these responsible for inspecting about 5 to 6 miles of line every day, and at the same time leaving open and unguarded all the unimportant level crossings where conditions of visibility were sufficiently good.

In spite of this, the number of employees, which was 0.60 per 1 000 train-miles during the year 1914-15, increased to 0.69 in the year 1920-21, that is to say, an increase of about 16 %.

D) Finally, we have the *workshop and stores staff*, for whose working hours the following rules were adopted :

1. — Length of working hours : eight hours per day;

2. — Breaks in working hours : as a rule one or two hours at least, in some cases these might be reduced to half an hour;

3. — Periodical rest days : no work on Sundays and on six other local fete days. As regards other fete days, a holiday may be taken in lieu of another Sunday.

Before the application of the eight hour day, shopmen worked as a rule ten hours per day, while in the sheds up to twelve hours might be worked. In the workshops attached to the engine sheds, the men had one day off every fifteen days with pay. The employees in large workshops were free on all Sundays and civil fete days, but were not paid for these days. Finally, the stores staff were free on one fete day out of two and on the next fete day only worked half time, in every case receiving pay. In 1914-15, the employees of these categories were about 0.31 per 1 000 train-miles, and in 1920-21 had increased to about 0.50, that is to say, an increase of 63 %.

This considerable increase is, however, only partly due to the adoption of the eight hour day and of the weekly day off, because an increase in staff of this category is not influenced by the special conditions due to the running of trains, but depends solely on their output.

The reduction in the working hours from an average of ten hours to eight hours would require an increase in the staff of 25 %, but with the adoption of a weekly day off instead of every fifteen days for about two-thirds of the staff in question, this might lead to a total increase of 32 %, that is to say, about half of the actual increase of 63 % which has been quoted. The other half is due to other causes which are difficult to express in figures, but which have a very real influence, such as the following :

— the reduced output in general of the workers due to their unsettled state and lack of discipline;

— the increase in the number of absentees through various reasons, such as sickness, accidents, strikes, holidays, etc.;

— the increase in the amount of repair work to the rolling stock due to the heavy traffic carried during the war, which in addition to the large amount of work carried out by private firms, necessitated an increased output from the out-station shops and principal repair shops of the State Railways.

The method of obtaining special exceptions to the limits of working hours or rest periods was entrusted, as far as footplate and train staff were concerned, to local committees who were charged with revising the working rules, of which, however, very limited use was made. On the other hand, for employees of other categories, no special restrictions were adopted, except compensation for a short working day or extended period of rest, or as regards payment of overtime.

As regards exceptions which occur for occasional or temporary reasons, these were limited to a few special cases as regards footplate and train staff : delays, floods, snow, engine casualties while running or in stations where no running sheds exist, sudden death or illness during working hours. The case of late running of trains or such similar circumstances were excepted.

A characteristic feature of the first application of the eight hour day in Italy, is that it no longer made it illegal for traffic and train staff to leave their work after they had completed the number of working hours fixed by law. The abolition of this rule, which was established by an earlier law dealing with the safety of railways, gave rise to great inconvenience in the running of trains during the years 1920-21.

All these measures which we have just mentioned as regards the first application of the eight hour law, gave rise to a rapid increase in the number of staff, which from a pre-war average of 2.01 per 1 000 train-miles, increased to 3.60, that is to say, an increase of 79 %, due mainly to the manner in which the eight hour day was applied, and due also to the excessive restrictions which had to be observed in drawing up the timetables and working rules.

The reaction which occurred in the country after 1921 against the tendencies of the preceding two years led gradually to a revision of the way in which the eight hour principle was applied. At the same time the principle was adopted that the eight hours should be hours of actual work and not merely of presence on duty. In accordance with the new point of view, new regulations were issued as regards the working hours of the staff of the State Railways, by Royal Decree No. 1631 of the 22 July 1923, according to which, where an employee was merely present on duty, a suitable coefficient (of two-thirds) was applied in calculating the equivalent length of actual work performed, the eight hour limit remaining, however, for work done by those of the staff who were employed on continuous work throughout the whole of their hours on duty. At the same time some of the restrictions which prevented a sufficient output being obtained were amended or repealed, and this produced a considerable improvement in the running of the railway, and also in the economic use of the staff, which has fallen to 2.48 per 1 000 train-miles, which is an increase of only 23 % over the pre-war figure, due to the concessions made as regards working hours and conditions.

In addition to these more important points, it is interesting to follow in table (appendix No. III) the variations in the number of staff employed by the traffic department during the years 1914 to 1924 in absolute figures, and also as a ratio of the traffic handled compared with the last normal financial year 1913-14.

III — Comparison between the various States.

We have already considered the conditions which were widely established in Italy in the first application of the principle of the eight hour day.

These conditions are at the present time different in essentials, as may be seen from the new rules which we have just been discussing as regards the staff of the various categories. These rules will again be mentioned later and compared with similar rules adopted by the three other countries.

In order to compare what has been done by each State in adopting the eight hour day in a permanent and definite manner, it is necessary to recall the rules which were formerly in force. As far as Italy is concerned, we have already given the necessary information in this respect when speaking of the first application of the new principle, and consequently before proceeding to a brief review of the present day rules for employees of each category, we will in the first place give the rules formerly existing in the three other countries : Switzerland, Spain and Portugal.

1. — Rules concerning employees of various categories.

a) Footplate and train staff.

(See table 1.)

In Switzerland, the application of the eight hour day has not given rise to any great disadvantage, because the rules adopted have a considerable amount of flexibility and consequently did not prevent efficient use being made of the staff, and also because the rules which were formerly in force were already fairly generous in this respect. Thus, for example, the total length of the working day did not on the average exceed fourteen hours, and the maximum amount of actual work performed per day was eleven hours. The ordinary period of rest of ten hours might be reduced, however, to a minimum of eight hours, except for one period of rest out of three, which had to be ten hours at least. The number of days off was already fifty-two per year, each period being of 32 or 34 hours; periods reckoned as overtime were not changed after the adoption of the eight hour day. The same holds good as regards the less important limitation of working hours.

In Spain, before the application of the eight hour day, there were no rules for determining the working hours of footplate and train staff. However, the length of the days work was on the average ten hours, except for footplate staff, who only had to work nine hours, the rules being drawn up by the administration in the way that they thought most suitable; employees were given a day off every fifteen days. The rules as regards the eight hour day have been drawn up in a sufficiently reasonable and flexible manner, so that the adoption of this principle has not had any very adverse effect on the industry.

In Portugal, on the other hand, before the application of the eight hour day, there were regulations for controlling the working hours of the staff : the hours worked could not exceed one hundred and sixty-five hours in fifteen days, that is to say, eleven hours per day on the average; the maximum time at work between two ordinary periods of rest could be as much as fifteen hours; the periods of rest could not amount to less than 150 hours in fifteen days, that is say, ten hours per day on the average; the period at work between two ordinary periods of rest might be as much as eighteen hours; the minimum ordinary period of rest was eight hours at home and six hours when lodging out. It was possible, however, to have not more than two consecutive periods of rest of less than seven and a half hours; periods of rest less than one hour and standing time less than one and a half hours between the arrival of one train and the departure of another were counted as time worked; periods when waiting as spare staff were calculated at a quarter of full rate; other limitations of minor importance were included in the working rules for footplate and train staff.

b) Station and shed staff.

(Traffic and locomotive departments.)

(See table 2.)

Formerly, in Switzerland, the working day could not exceed eleven hours; the period of rest was eight or nine hours at the minimum, in accordance with whether employees lived close to their place of employment or otherwise; there were fifty-two days off per year.

In Spain, the eight hour day was only granted in the first place for employees of the locomotive department. For station staff, on the other hand, it was arranged that the staff might be required to work up to twelve hours the time, in excess of eight hours being paid as overtime. Latterly, the eight hour day has been granted, but the hours when the staff were merely present on duty was counted at half rate. Formerly, the hours of actual work were as a rule ten to twelve; there were not, however, any definite rules on this subject.

In Portugal, the principle of the eight hour day for staff of the category in question is subject to the condition that the hours on duty may be prolonged to nine, ten or eleven hours in unimportant stations. Formerly the work was regulated by special rules in accordance with which the hours of station staff might extend to twelve hours, and the minimum period of rest might be as little as seven hours if the work performed was not particularly arduous. It would appear that there were no periodical days off, and we have no information as regards what has been done in this respect since the adoption of the eight hour day.

c) **Permanent way staff.**

(See table 3.)

In Switzerland, for the permanent way watchmen, the hours of work were formerly eleven per day, and the minimum period of rest nine hours; fifty-two days off being allowed. The same applied to the maintenance staff, except that the latter did not work on Sundays and other general holidays.

In Spain and Portugal it would appear that there were no legal regulations controlling the hours of work and rest before the adoption of the eight hour day.

d) **Workshop and stores staff.**

(See table 4.)

As regards Switzerland, the information received only tells us that the staff in question formerly worked nine hours.

In Spain, on the other hand, as a rule ten hours were worked, but there were no regulations for fixing this.

In Portugal similarly there were no regulations as regards the working hours of the staff other than those actually engaged in traffic movements.

e) **Regulations concerning employees of all categories.**

Some of the regulations dealing with the work of the staff in general are of considerable importance and worthy of special attention.

Complaints.

Complaints made by the staff as regards the working hours and regulations, or against any exceptions made in practice, are dealt with in a manner which differs for different countries and for employees of different categories.

ITALY. — For employees of all categories complaints are dealt with in the first instance by the head of the section, office or workshop, in which the men concerned are employed, and secondly and finally by the chief of the department or by the managing committee.

SWITZERLAND. — The legal regulations have always laid down and still maintain that the staff should apply to their immediate superior, so that he may suitably deal with any exceptional cases within the limits of the law, or with those which have not been officially authorised. In every case he should, without delay, inform the parties concerned of the decision which he has taken, and the employee may then apply to the railway department. In the workshops, the determination of the working hours and any change therein should be decided upon in agreement with the employees.

TABLE 1.

a) Footplate and train staff.

SUBJECT.	*Limits decided upon in*			
	Italy	*Switzerland.*	*Spain.*	*Portugal.*
1. *Average length of hours at work.*	48 per week.	8 per day as an average over 2 weeks.	8 per day on the average over one turn of duty or over one month.	48 per week or the equivalent amount per month.
2. *Maximum interval between two ordinary periods of rest* (Working hours.)	12 hours (14 hours if the effective work is less than 8 hours or if it is interrupted by a period of rest of at least 4 hours).	15 hours (averaging 13 hours over 14 days).	14 hours (16 for light duties or on local lines).	18 hours.
3. *Maximum amount of effective work between two ordinary periods of rest.*	10 hours (9 for footplate staff employed on express or similar trains).	10 hours.	13 to 14 hours.	15 hours.
4. *Method of calculating :* a) *when waiting orders at the shed;*	At the rate of two-thirds.	At half rate.	At one-third rate.	At quarter rate (half rate for drivers and firemen on engines in steam).
b) *when travelling as passengers.*	Ditto.	Ditto.	Ditto.	...
5. *Hours of additional work :* a) *before the departure or after the arrival of trains;*	As a rule : 30 minutes before departure and 50 minutes after arrival for train staff. 60 minutes before departure and 60 minutes after arrival for footplate staff of steam locomotives, and 45 minutes before departure and 45 minutes after arrival for electric locomotive staff, which may be reduced to 30 minutes before departure and 30 minutes after arrival for a journey not exceeding one hour in duration	According to circumstances, 12 to 30 minutes before departure time for footplate staff; and 5 to 7 minutes after arrival time according to the nature and composition of the train. For train staff, 5 minutes after and 5 minutes before.	1 to 1 1/2 hours in accordance with circumstances. ...	According to circumstances. ...

	staff) which may be reduced to 12 after a working period not exceeding 6 hours rest (5 for footplate staff).	exceptional cases 11).	working period of 13 hours).	
b) *lodging out.*	8 hours which may be reduced to 7 if compensated for either before or after.	Ditto.	8 hours (10 after a working period of 13 hours or more).	9 hours.
7. *Periodical days of rest :*				
a) *number per year and minimum duration ;*	52 each of at least 36 hours.	56 to 24 hours increased by ordinary period of 9 hours at least.	24	36
b) *maximum interval between two successive days of rest.*	8 days (in exceptional cases 30).	14 days.	10 day.	14 days.
8. *Night duty :*				
a) *between what hours ;*	Midnight to 5-0 am.	From 11.0 pm. to 5.0 am.	...	...
b) *maximum number of consecutive nights on duty.*	4	7	...	...
9. *Maximum time away from home.*	...	...	...	...
10. *Maximum mileage between two ordinary periods of rest.*	...	...	...	...
11. *Interval between the arrival and departure by the same train or with another train, which is reckoned as work.*	2 hours for footplate staff and 90 minutes for train staff.	15 minutes.	From 1 to 2 hours on various administrations.	1 hour and 1 1/2 hour.
12. *How are the working hours determined ?*	In accordance with the timetable, increased in cases of late running.	In accordance with the timetable, taking into consideration however late running exceeding 15 minutes.	On the actual time of arrival.	On the actual time of arrival.

TABLE 2.

b) Station and shed staff.

(Traffic and Locomotive Departments.)

SUBJECT.	*Limits decided upon in*			
	Italy.	*Switzerland.*	*Spain.*	*Portugal.*
1. *Length of daily working day.*	8 hours of effective work on the average calculating presence on duty when unoccupied at two-thirds rate.	8 hours on the average over 2 weeks. Maximum per day, 10 hours.	8 hours as an average over one month (reckoning simple presence on duty at half rate).	8 hours at important stations. 9, 10 and 11 hours in other cases.
2. *Length of ordinary period of rest :* a) *employees living close to place of employment ;*	9 hours at least in each period of 24 hours.	10 1/2 hours as an average over 14 days.	No special rules.	12 hours.
b) *in other cases . . . .*	Ditto.	11 hours as an average over 14 days.	...	Ditto.
c) *minimum period. . . . . . .*	8 hours where compensation is made.	10 hours.	...	Ditto.
3. *Maximum number of periods of work into which the working day may be divided.*	...	As a rule, not more than 4.	As a rule, into two periods.	As a rule, into two periods.
4. *Maximum interruption which can be calculated as time worked.*	All those of less than one hour.	15 minutes.	...	...
5. *Days of rest. . . . .*	52 of 24 hours in addition to ordinary periods of rest after duty, with a minimum of 30 hours when changing shift.	56 of 24 hours each (preceded by a period of rest of at least 9 hours, 26 days of rest falling on a Sunday or fete day, in each year .	24 hours every 15 days. No special rules.	Not given.
6. *Consecutive nights on night duty . .*	Six.	Not more than 7 consecutive nights or 14 nights in 4 weeks.	No special rules.	Normally, 8 nights.

Spain. — Complaints are addressed to the immediate superior and are examined by competent authorities. At the present time industrial tribunals are in course of formation.

Portugal. — Employees may address their complaints to the companies, to the government department, or to the Minister of Labour.

Holidays.

In addition to the ordinary days off, it is usual to grant the staff holiday periods of greater or lesser length with pay. In this respect, however, there are considerable differences between the different countries and between employees of various categories.

Italy. — Holidays are granted to the permanent staff as follows, in accordance with whether they have or have not completed ten years of service :

Twenty-six or twenty-one days per year for staff of grades equal to or superior to grade 10 (chief clerk, assistant chief clerk and similar grades), and also drivers and firemen;

Twenty-six or sixteen days per year to staff of grade 11 (clerks or similar grades), to grade 13 (foremen and similar grades), workmen excluded;

Sixteen of thirteen days per year to workmen or employees of the two last grades (14 and 15).

Holiday time includes periodical days of rest which occur during the holiday period.

The concession of holidays on the above scale coincided with the application of the eight hour day. Formerly there were three less days holiday per year for each of the grades mentioned, and this measure has also had an effect in the increase in the number of staff which we have already mentioned. As regards workmen in the workshops, the holiday with pay was increased from five days to sixteen or thirteen days in accordance with the length of service.

Switzerland. — The number of holidays per year for the permanent staff is :

7 days for the first nine years in the service;
9 — after 10 years in the service or at 30 years of age;
12 — — 15 — — — 35 — ;
15 — — 20 — — — 40 — ;
18 — — 25 — — — 55 — ;

Those not on the permanent staff, but who work continuously or almost continuously on the railway are also entitled to a holiday with pay for a number of days, which varies in accordance with the length of their service.

Spain. — It is only employees directly employed by the operating department (drivers, firemen, mechanics and labourers in the sheds, gangers, etc.) who are entitled to a holiday, with pay, of fifteen days per year. This is in accordance with the information supplied by the Madrid-Saragossa and Alicante Company. On the other hand, from the information sent in by the Northern Railway of Spain, the privilege of fifteen days holiday is general, this referring of course to the permanent staff.

Portugal. — The only administration which has replied to the questionnaire, the Portuguese Railway Company, grants a holiday, with pay, of twenty days per year, only to the office staff.

TABLE 3.

c) Permanent way staff.

SUBJECT.	*Limits decided upon in.*			
	Italy.	*Switzerland.*	*Spain.*	*Portugal.*
	1° Supervision of permanent way.			
1. *Length of working day*	8 hours of effective work on the average, calculating periods when merely present on duty at two-thirds rate.	8 hours on the average over 14 days, which may be increased to 9 hours if there are periods of merely being present on duty of more than one hour, this being reckoned at half rate.	8 hours; increased hours up to 12 are allowed where paid for as overtime.	8 hours at important level crossings. 12 in other cases. Unimportant level crossings are closed at night and are supervised by the permanent way watchmen's family.
2. *Minimum length of ordinary period of rest.*	9 hours in each period of 24 hours. (8 hours where compensated for.	10 1/2 hours on the average if residence is close at hand, and 11 hours in other cases. Absolute minimum: 10 hours.	No rules on this subject.	12 hours.
3. *Periodical day of rest.*	52 of 24 hours each in addition to ordinary period of rest after duty.	56 of 24 hours, preceded by an ordinary rest period of at least 9 hours, 20 days of rest falling on a Sunday or fete day.	There is no weekly day of rest.	...
4. *Consecutive night duty*	...	7 consecutive nights or 14 in 4 weeks.	...	7 consecutive nights.

1. *Length of working day*	8 hours on the average (the amount varies in accordance with the seasons from 7 1/2 to 10 hours).	48 hours per week on the average (not taking into account time walking to work, except where this is to proceed to another section; in such a case it is reckoned at half rate).	8 hours on the average (7 hours in winter and up to 9 hours in summer).	8 hours per day and 48 hours per week.
2. *Ordinary daily period of rest* . . .	As for permanent way watchmen.	As for permanent way watchmen.	As for permanent way watchmen.	As for permanent way watchmen.
3. *Periodical days of rest*	Off duty every Sunday, except one man of each gang, this duty being taken in turns and another day off being given in place of it.	As a rule, off duty on Sundays and general fete days.	Free on one fete day out of two.	Days of rest taken in turn.

TABLE 4.

d) Workshop and stores staff.

SUBJECT.	*Limits decided upon in*			
	Italy.	*Switzerland.*	*Spain.*	*Portugal.*
1. *Length of daily working hours* . . .	8 hours par day.	8 hours per day or 48 hours per week.	8 hours per day.	8 hours per day or 48 hours per week.
2. *Is the working day divided by a short period of rest?*	As a rule it is divided into two periods by a break of at least two hours, which may be reduced in certain cases, to 1 1/2 hours.	Yes, with an interval of one hour or 1 1/2 hours for rest.	Yes, a break of one or 1 1/2 hours without leaving the premises.	Yes, by a period of one hour.
3. *Periodical days of rest*	As a rule, the workshop is closed every Sunday and the staff are off duty (with pay). They may be free on a fete day by working on the preceding or following Sunday.	The staff at workshops and sheds are off duty on 20 Sundays or fete days. At the principal workshops and stores attached thereto, the staff are free on all Sundays but without pay.	Off duty every Sunday, but without pay. This does not apply to employees of the traffic department, who have one fete day off duty out of two with pay.	Off duty on all Sundays and fete days without pay.

2. — General rules.

In order to make a proper comparison between the various countries, it is necessary to consider also the general rules now in force in each of these for regulating the work of the railway employees.

Italy. — The application of the eight hour day to the State Railways is at the present time controlled by the Royal Decree No. 1631 of the 22 July 1923 (appendix V). Secondary railways and tramways come under Royal Decree No. 2328 of the 19 October 1923 (appendix VI).

By the first of these Decrees, the average hours of work is fixed at eight per day or forty-eight per week; actual working time is counted at its full value, while time spent in waiting on duty is counted at two-thirds full value; breaks of an hour or more are not included, nor is time taken proceeding to or returning from work, even if this entails travelling. The daily period of rest may not be less than nine hours, while the weekly rest is twenty-four hours in addition to the ordinary rest (this may be thirty hours only when changing shift); work performed between midnight and 5.0 a. m. is considered as night work and may not be worked for more than six consecutive nights.

The Decree provides for modifications in exceptional circumstances, or due to the necessities of the service, with compensation for additional work done, but the most important clause is that whereby « in any case the staff may not leave their work without being relieved on the plea that they have worked beyond their proper hours ». It is provided that the periodical rest days may be postponed (except for footplate and train staff) for one month and may in this case be taken two together.

By the Decree dealing with the secondary railways and tramways, the principle of the eight hour day is applied in a less rigid manner : thus, for example, for footplate staff, periods when waiting as spare men or available at their homes are counted at a lesser rate (half or quarter only). The same is the case when travelling as passengers or performing any other accessory duties which cannot be defined; working periods are increased to fourteen hours and ordinary periods of rest at home are decreased to ten hours. For the remainder of the staff in general, while time spent in waiting on duty is reckoned at half instead of two-thirds, working hours are longer and ordinary periods of rest are shorter, as is also the periodical time off.

The principal characteristic of these Decrees is that they provide that the eight hours shall be hours of effective work; periods of presence on duty when no actual work has to be performed are reckoned at an appropriate reduced rate. This forms a radical modification in the principle of the eight hour day and applies this in a rational manner, which, while respecting the legitimate and long standing aspiration of the workers which has now been granted, does not on the other hand impose such exhorbitant demands on the industry.

In practice, as regards footplate and train staff on the State Railways, although during the first application of the eight hour principle, they did not work on the average more than 19 h. 38 m. and 25 h. 33 m. per week respectively of *useful work* (*while working trains*), after the application of the Decree No. 1631 of the 22 July 1923, this useful work increased respectively to 26 h. 34 m. and 33 h. 34 m., that is to say, an increase of 35 and 33 % respectively. By subsequent modifications in the working regulations, other improvements in the output of the employees of this category have been obtained.

Equally satisfactory results have been obtained by applying this Decree to the staff employed at stations and locomotive sheds, as well as those employed on inspecting and cleaning rolling stock and in inspecting the permanent way.

Another factor which, in addition to the new rules for controlling working hours, has contributed to a better output from the staff and a greater regularity in the service which has now very much improved, is the new spirit of discipline which has developed throughout the nation, and which by reviving a sense of duty among the masses has eliminated the more unreasonable sources of trouble.

SWITZERLAND. — As regards the traffic department pure and simple, the working hours of the Swiss railwaymen are still fixed by the Federal Law of the 6 March 1920 (appendix VII) by which was adopted the eight hour day on the railways. Special restrictions had already been made for the staff of various categories.

Foreseeable circumstances are provided for in detail and have been drawn up with the agreement of the staff, compensation being allowed. The daily working hours may be increased by one hour, in the case of heavy traffic, for a period which may be extended up to five months; the length of a working day may also be increased to fifteen hours; the period of rest may be reduced to nine hours; the hours worked in the workshops may be increased by two hours per day over a maximum period of eighty days; periodical rest days may be postponed.

Beyond this, under special circumstances, such as late running of trains, dislocations in the traffic, a considerable increase in the number of passengers, or other important causes, the staff may be employed beyond the limits of the fixed hours.

However, if for any such reason the legal limit is exceeded by more than a quarter of an hour, a corresponding compensation or remuneration is paid.

After this law came into force, the Federal Council only applied article 16(1) to lay down as a special case an increase of half an hour per day in the length of the hours worked in the case of employees of the following categories :

a) staff employed in the maintenance or inspection of the permanent way, from the 1st April to the 31 October of each year;

b) train staff;

c) staff employed in repairing or cleaning rolling stock.

This exception is, however, merely a temporary arrangement up to the 1 June 1925. Its subsequent extension to employees of other categories and beyond the period stated cannot be brought into force until the special conditions cited in article 16 are satisfied. An increase in the working hours has been agreed to in order to avoid an increase in the staff as the result of the growth of traffic.

Thus, the Swiss law as it stands provides for daily hours of work exceeding eight hours, when such work consists of a considerable proportion of merely being present, but in contra distinction to the Italian law, it limits to nine hours (or as a temporary measure to nine and a half hours), the hours of work in such cases.

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(1) 1° When special circumstances render it necessary, the Federal Council may, after coming to an agreement with the staff concerned, authorise departures from the existing law; 2° Special powers may in particular be granted to secondary railways as regards working hours and regulations, as well as regards days of rest.

Moreover, the law establishes, both the average hours of work and also the average time on duty, and the average period of rest over a period of fourteen days; these limits are not provided for in the Italian law. As regards the other principal limitations, the Swiss law provides as follows :

the maximum length of the working day is to be fourteen hours (or as an exception fifteen); these, however, may be exceeded in the case of late running of trains, but should be compensated for within three days;

the minimum ordinary daily period of rest shall be ten hours (or as an exceptional case nine) without making any distinction between rest at home and rest when lodging out;

that from 11.0 p. m. to 5.0 a. m. should be considered as night work;

that the maximum number of consecutive nights at work shall be seven;

fifty-six periodical times off the length of the period being at least thirty-three hours, periods less than twenty-eight hours only being reckoned as half a period.

As regards the length of holidays, it also differs from the Italian law. These have been increased to the amounts given above, but they remain, however, generally speaking less than those allowed on the Italian Railways, except for employees of more than fifty years of age.

Thus, while in certain respects the Swiss law is more favourable to the staff than is the Italian law, in other respects it is less favourable. On the whole it may be said, however, that it presents less flexibility in its application, and also makes provision for its non observance in special cases.

Spain. — The eight hour day was imposed by Royal Decree in April 1919, which entrusted its application to the public services to the decisions of the special committees which were set up for employees of each separate category by the Royal Decree of the 2 August 1919 and which were composed of representatives of railway companies and of the staff concerned.

The application of the eight hour day did not therefore take place simultaneously for the staff of all categories. It was extended at various times during the years 1919-20-21, in accordance with the findings of the above mentioned committees.

After its first application, no modifications have been made, so that the various limitations which controlled working hours and periods of rest are those which we have already quoted.

On these railways the principle is also observed that time spent on the premises when not doing actual work should be calculated at a reduced rate and should in effect be reckoned at half rate. The total hours of employees may in this way be extended to three hours over and above the eight hours.

Portugal. — For the Portuguese railways also, the first regulations brought into force when the eight hour day was instituted are still in operation, for, according to the information which we have received, there has been no necessity to amend these. Without repeating the various legal details, we may mention, however, that the average of eight hours per day, or forty-eight hours per week refers to a period which must not exceed one month; the length of time on duty may as a maximum reach eighteen hours, which is the highest figure of all similar regulations in force in the other countries dealt with; the same applies to the maximum hours worked between two periods of rest, which may extend to fifteen hours. On these railways also presence on the premises without doing actual work is reckoned at a fractional rate : periods when waiting as spare men are reckoned at a quarter, except for enginemen in charge of engines under steam, for which they are reckoned at half. By the same principle, the hours of employees who do not have to work continuously may extend to eleven hours per day. On the other hand, the rest periods of footplate and train staff are fourteen at a minimum when at home and nine hours when lodging out, except in cases where light duties have previously been worked. No difference is made between day work and night work, and in consequence there are no special limitations as regards the latter. By reducing the hours of actual hours of work to eight, no radical modifications have been made in the original rules, which consequently still have considerable flexibility and allow the companies to obtain efficient use of their staff.

3. — General considerations

To summarise, one may say, that before the introduction of the eight hour day, in general ten hours were worked per day for employees of categories which were employed continuously and not less than this amount, except in exceptional cases for categories engaged on particularly arduous labour or having responsibility.

On the other hand, employees whose service consists partly by merely being present on the premises worked twelve hours per day.

If the principle of eight hours work is applied in a fair manner, by reckoning on a suitably reduced basis time spent on duty without performing actual work, so that in all cases eight hours effective work shall be performed, in the same way that formerly, a similar reduction in the hours of presence on duty without performing actual work, to the equivalent of ten hours on actual work, led to the working hours extending to eleven or twelve hours which were in force, the change from ten to eight hours should, broadly speaking, lead to a reduced output of 20 %, and should therefore cause an increase of about 25 % of staff in order to perform a similar amount of work under similar conditions.

Of the four countries with which we have been dealing, only Switzerland has not made any appreciable increase in the number of staff, either because the original conditions of labour were a near approach to the principle which was adopted, or as the result of other circumstances, such as the appreciable reduction in the traffic and the simplification of the service which neutralised the effect of the decreased working hours.

As we have seen in Italy, the number of staff increased in the first place from 2.01 per 1 000 train-miles to 4.09, and finally fell to 2.48; that is to say there has been an increase of about 23 %.

In Spain, the increase in staff given as a consequence of the eight hour day has been as follows :

about 25 % for the Northern Railway (2 418 miles);

about 30 % for the Madrid, Saragossa and Alicante Railway (2 276 miles);

about 30 % for the Andalusian Railway (1 058 miles).

Finally, in Portugal there has been, as the result of the application of the eight hour day, an increase in the staff of 100 %. This last proportion is particularly high, and it would seem to be due to the very long working hours which were formerly in force, or perhaps also to other causes outside the scope of this report.

IV. — Note on the methods of applying the eight hour day.

The experience which has been gained in Italy is especially instructive owing to the excessively broad way in which the principle was adopted in the first place, and in view of the subsequent more reasonable amendments, which enables one to state that if the adoption of the eight hour day has produced an increase in the number of employees far beyond what was anticipated, even perhaps by the trade unions, which advocated the measure, this was especially due to all the restrictions with which it was encumbered, which interpreted the principle in a way totally incompatible with the requirements of railway service.

In fact, if one can allow only eight hours on duty for all the staff whose work is continuous, as is the case in the workshops, it would be impossible to do the same for work of an intermittent nature or where employees have merely to be on duty without performing any actual work, as is the case with a large number of categories of railwaymen.

The adoption which was made of eight hours, in the sense of eight hours on duty and not eight hours of work, soon had disastrous effects, both as regards the financial position of the railways and also as regards the regularity of the service, which made it obvious to all that it was impossible to maintain this principle on such a totally erroneous basis.

In fact, after the first information as regards the consequences of the application of the eight hour day, furnished by a few competent authorities, the question received considerable attention from the press and from public opinion itself. In Italy, and in other countries, the matter was also discussed in parliament, and prominent individuals in the parties which had supported the new concessions had to admit that the *eight hours should be hours of actual work and not merely of presence on duty.*

An acknowledged expert on railway matters, Senator Richard Bianchi, formerly General Manager of the Italian State Railways, expressed himself in a speech in the Senate on the 22 June 1922 in the following manner :

> The eight hour day is now recognised throughout the world as necessary : the most prominent socialist deputies have clearly stated to the Supreme Labour Council that the eight hour day is necessary for industries which demand continuous physical labour, and it is not to be thought that the eight hour day should be applied where physical labour does not exist. The remedy for applying this principle of eight hours is very simple and might consist of two measures : eight hours for those who perform effective work (as for example footplate and workshop staff, etc.); but in other cases where the duties consist largely of being present without performing any actual work, it is necessary to make an adjustment and require a larger number of hours on duty by fixing a rate whereby these hours can be reckoned as equivalent hours of effective work.

The same view was supported by Mr. Pierre Lanino, President of the College of Railway Engineers, in an article written in 1922 on « The Railway Deficit ».

The application of eight hours of work « he said » as demanded by the staff and submitted to the government and accepted by the administration, shews itself in its excessive measures as incompatible with the requirements of the service and by reason of its exaggeration, it jeopardises a principle which in itself is very just and which no one would wish to oppose. By carefully examining what has been done in the railway world, it will be very clearly seen that the application of the eight hour day has been transformed from a domestic measure, introduced with the object of improving the conditions of work for the railway staff, into a wider measure intended particularly to reduce unemployment.

Unemployment has been a special feature of post-war times. It has happened that a large number of workers, who during the war were taken from agriculture or from factories, when they returned, were unable to be immediately taken on by peace time industries, which, having been depressed during the war, did not find themselves at the time of the armistice under favourable conditions to make a rapid recovery to prosperous conditions. To this must be added the small demand for labour in overseas countries, which led to a diminution of emigration and also the unwillingness of a number of agricultural labourers to return to this arduous form of occupation.

The demobilisation of war-time industries also contributed in a large degree to the increase of unemployment.

In order to overcome this, the application of the eight hour day appeared very suitable, since it limited the work of the individual and therefore offered the possibility of being able to employ a larger number of workers. This feature might in the first place have justified the principle of the eight hour day, which was recognised throughout the world as being equitable, but which degenerated in its method of practical application.

In addition to this opinion of our experts, it appears opportune to also examine the opinions which have been expressed by other speakers, outside Italy, in the field of politics and of general economics. The essential points in the opinions which have been quoted, is the statement that the eight hour day should be maintained, but that they should be eight hours of effective work, and not merely of presence of duty. This latter time should be calculated as hours worked only for applying a suitable coefficient of reduction.

This opinion was even admitted by deputies of the extreme left in a highly important sitting of the Italian parliament (12 May 1922). On this occasion Mr. Donati, one of the most influencial deputies, stated : « Since the eight hour « day was generally accepted throughout « the world, no one has claimed that the « eight hours should not be eight hours « of work, but that they might be eight « hours of idleness. »

The question has also been widely discussed in other countries. A very complete and carefully written article on « The eight hour day in France » by Robert Veyssié, was published in 1922. We will extract a few important statements :

Mr. Marcel Peschaud, General Secretary of the Managing Committee of the principal French Railways, expresses himself thus :

As regards the principle, bearing in mind that nothing is absolute and that all reforms should be in accordance with the times and conditions, my opinion is that the least that can be said of the eight hour day is that it is essentially unsuitable at the present time.

In speaking of the amendments to be made to the law in this respect he asks :

1° That the eight hour day should be eight hours of *actual* work and not of being present on duty, and that an adjustment should be made in consequence in the case of all occupations in which continuous effective work is not performed, the hours on duty being in accordance with the nature of the employment and exceeding to a greater or lesser degree the statutory hours in the case of occupations in which work is not performed continuously;

2° That the eight hour day should be calculated on the *average* over a period consisting of a whole year, in order to obtain, without inconvenience to the needs of the service, an average of eight hours of actual work;

3° That a margin of 300 hours should be allowed the administration on this total.

Mr. A. Mamelet, General Secretary of the Democratic and Socialistic Republican party expresses the following opinion :

We do not think that it would be wise to abandon the principle, but we ask that its application should be as flexible as possible in order to meet economic needs.

Robert Veyssié, at the end of the article which we have mentioned, concludes in these words :

All things being considered, after having weighed the various diverse opinions and having examined the economic arguments, while keeping in mind all the psychological aspects of the case, I have arrived at this conclusion : the act of the 23 April 1919 *ought not to be repealed or suspended;* but it is absolutely necessary that a definite ruling should be arrived at as to its application;

It is absolutely necessary to establish the *principle that the work must be effective work,* it is wrong and illogical that the same working hours should be fixed for all classes of employment, as this would be the equivalent of legalising idleness;

It is necessary that working hours should not in every case be fixed at so many per week, that is to say, they may be calculated either per day, per week, per fortnight, per month or per year, according to the respective conditions or needs of various industries;

Means should be provided for recovering hours of work lost through any frequent causes which are not now taken into account, and to lay down regulations whereby this may be done;

It is necessary that provision should be made in the law for temporary exceptions;

Finally, it is necessary that the law should state clearly that an employer should be able to use all the said exceptions without being obliged to submit them to bureaucratic methods such as authorisation by works inspectors.

This was the programme on the question with which we are dealing, which was carried out in a Decree of the 14 September 1922, promulgated in France on the proposal of the Minister of Public Works, Mr. Yves Le Trocquer.

Without entering into details of this law, which is dealt with by Mr. Soulez, the other reporter on the question of the eight hour day, we cannot, however, abstain from making a few remarks on the more important points. The amount of *effective* work is calculated per year on the basis of an average of eight hours per day for 313 days, that is to say, excluding the 52 weekly days of rest.

This implies very great flexibility in

the distribution of working hours and consequently in the possibility of making up for time lost, either by reason of the seasons or through other unforeseen causes. The principle in accordance with which the average working hours of effective work are limited to eight hours is clearly confirmed by the law, which allows average working hours up to but not exceeding twelve for employees whose work is intermittent. It also allows a working day up to fifteen hours for female gatekeepers who may leave their post to go into their house, and for employees living close to their work who may at the most be occupied for six hours as gatekeepers.

To complete a short review of the opinions of experts on the question of working hours, we may also quote the opinion of medical science. Doctor L. Verney, writing on « The eight hour day » (*Annales d'hygiène*, XXIX year, vol. IV, 1919), says :

> One of the things which has to be accomplished in the near future consists of *calculating the length of working hours in according with the work performed,* because it is not reasonable to adopt a general rule applicable to all forms of work.
>
> It has been clearly shewn by Doctor H. M. Vernon, who has made a large number of tests on workers on behalf of the British Ministry of Munitions, that the length of the working day should *vary between very wide limits* in accordance with the various occupations. The need for this is very obvious.
>
> The reduction in the hours of work might be very useful from a social and hygiene point of view; it would leave a greater margin for intellectual improvement and for relaxation, but one cannot deny that there is an inherent danger that it leads, in the case of a certain number of individuals, to idleness and unhealthy recreations.

From the whole of the opinions which we have quoted, it will be seen that there is no opposition to the principle of eight hours of work, but on the other hand it is none the less clearly shewn that in general it is necessary to regulate the application of this principle in a reasonable manner, taking into consideration the different nature of various forms of work and the different conditions under which this is performed.

V. — Summary.

The solution which has been definitely adopted in applying the eight hour day to railway workers in the four countries dealt with in our report, agrees with the opinion which has been expressed in the most competent circles for a fair and rational application of a principle which may be looked upon as a great step in our social system.

In spite of the limitations of the present article, it appears opportune to draw up certain statements of a general nature, summarising the results of the investigations and experience, so that having regard both to the needs of the service as well as to the claims of the staff, one may arrive at an arrangement of working hours which, without being excessive for the employees, may allow railway administrations to make efficient use of their labour.

It may be well in the first place to

state and emphasise the principale that *the length of working hours should be fixed in accordance with the nature, intensity and continuity of the work performed, making a clear distinction between effective work and mere presence on duty.*

Work can only be reckoned as effective when it entails careful and continuous exertion and when this has to be maintained during the whole of the working hours, these should not exceed eight per day. One arrives in this way at a fundamental basis of the principle under discussion, and the staff will be guaranteed against any excessive work which may impair their health and will be sure of adequate periods of rest.

If the conditions laid down above are not fulfilled and *if the work is intermittent or merely consists of being present on duty, the hours on duty will of necessity have to be reckoned as only partial work* and the ratio will be greater or less in accordance with the amount of effective work carried out during the period.

For this period it would appear that reckoning hours when merely present on duty at a value of two-thirds would be quite fair. In practice, if one reckons separately the proportion of this period in which effective work is performed and the proportion of presence on duty, and if one reckons the former at unity and the second at two-thirds, this will result in hours on duty which may vary between eight and twelve; the limiting case will only occur when it is only a matter of being present on duty throughout the whole period, that is to say, when no useful work is performed. In this case the employee may well be occupied on duty for a longer period, because it entails no fatigue and it is possible for him to eat during his hours on duty as he would be allowed to do; it therefore follows that his occupation does not cause him to be over worked, and in consequence he has no ground for complaint. On this basis one can conveniently fix the work of employees, such as supervisory staff, inspectors or manual workers.

The work which has to be performed is not always uniform and constant every day or throughout every season of the year. In order to adhere to the principle of eight hours of effective work and at the same time to meet the various requirements of the service, it is, generally speaking, advisable to *fix the number of effective working hours by periods of more than one week, that is to say, per month, or preferably per year,* seeing that for work which is affected by the seasons, it is only in this way that one can regain during the summer the time which has been lost during the winter.

In order to meet the special requirements which may at certain times occur in the traffic department, by an increase in the traffic or by other temporary causes, we believe that it is necessary to provide that a certain number of additional hours of work may be required each month or each year, the pay for which should in fairness be fixed at a higher rate than for ordinary work.

The minimum period of rest between two periods of work is especially important for the staff at little stations with an infrequent service and as regards footplate and train staff. In the first case, it is necessary to fix a sufficiently short period to allow a period of work, between two consecutive periods of rest, so that it may be possible to avoid employing two shifts of men in order to carry out a service where this is not continuous. With this end in view, one *may fix ten hours as the minimum period of rest, to be reduced to nine when the em-*

ployee lives at least 550 yards from his place of employment. In the second case (footplate and train staff) it is necessary to distinguish between rest at home and rest when lodging out.

In the interests of the staff themselves, *rest periods when lodging out should be only as long as is strictly necessary to obtain meals and recover from their exertions,* and may be limited to a minimum of eight hours (as an exception seven hours between two periods of light duty). *At home, on the other hand, a period of rest should be considerably more and should not in any case be less than twelve hours.*

For footplate and train staff it is also necessary to fix, as far as may be convenient, the period of work between two consecutive periods of rest and the maximum amount of work in the working period. We think, however, that it is necessary to distinguish between footplate and train staff, for the work of the former being much heavier should lead to shorter hours being decided upon for them than for the latter. As regards *hours of work, we believe that the following limits may be considered as fair: fourteen hours for footplate staff and fifteen hours for train staff, which may be reduced to twelve and thirteen hours respectively when the preceding hours of effective work have exceeded eight hours.* The maximum amount of effective work may be fixed at ten or twelve hours respectively, allowing a reduction of one hour for enginemen performing special important duties such as on express and similar trains.

The number of periodical days of rest should be fixed at fifty-two, not including the ordinary period of rest after duty. In order to facilitate changing over from one turn of duty to another, it may be useful to allow periods of rest of twenty-four or thirty hours. This rest should not, however, account for more than half or two-thirds respectively of a day off. For footplate and train staff, on the other hand, it may be well to provide for some time off being taken when at home in order to compensate for long periods when absent through lodging out.

For footplate and train staff, it is specially necessary to take into account the length of the additional time worked before the departure and after the arrival of the train and at intermediate stops between the arrival by one train and the departure by the same train or by another.

As regards this additional time, it may be well to remark, that in view of the way in which this may vary, it should not be attempted to fix this by any legal clauses, since this time depends on various circumstances and conditions (distance of stations from sheds, greater or lesser necessity for obtaining coal and water, etc.) which may cause these variations. *It should therefore be left to competent local authorities to fix in each case the amount of time necessary.* On the other hand, the length of these stops, in order to calculate the equivalent work, should be fixed beforehand, making a distinction between footplate staff and train staff. For the former, one may calculate as working time stops up to one and a half hours, and for the second, only those up to one hour, unless the time while stopping is occupied in effective work, either on the engine or on the train. In this case it should be considered as supplementary work.

In our opinion, it should not be necessary to take into account time occupied in walking to or from work.

It should not be necessary to fix any restriction *as regards the length of absences from home for footplate and train staff;* if, on the other hand, one wishes to draw up a rule in this respect, one should fix the limit at a fairly large number of hours (forty for example) so as not to prevent an efficient use being made of the staff.

The working hours of all the staff concerned in the running of trains should be fixed in accordance with the timetable, and not taking into account any late running less than one hour.

This tends to make it in the interests of the staff to avoid as far as possible any delay in the running of trains.

Definite rules should be adopted for night work. As a principle, *night work should be work carried out either solely or partially between mid-night and 5.0 a. m.*, because these are the hours which cause the greatest amount of fatigue to the staff, *and not more than six consecutive nights should be worked, or more then twelve nights on duty out of four weeks.* It may be, however, necessary to make exceptions to this rule in order to reduce the number of consecutive nights on duty for staff on very tiring work, for example, footplate and train staff, to at least four, and on the other hand, these limitations may have to be disregarded so that station or depot staffs may continuously work hours terminating before 1.0 a. m. or commencing after 4.0 a. m., since in this case it is only a question of postponing the time of leaving duty by one hour, and this does not constitute any great hardship for the employee. On the other hand, any limitation of night service is not possible in the case of the permanent way watchmen, in cases where by day their duties are carried out by *female gatekeepers, who in any case should be exempt from night duty.*

It may, however, be necessary to provide for exceptions, both in working hours and also in hours of rest; and also as regards the allowance of periodical time off or in the length of time allowed. In every case it should be formerly laid down that for no reason should the staff concerned in the running of trains be allowed to leave their work without being relieved on the ground that their working hours have been completed.

The staff should have means of drawing attention to any unjustifiable exception and against any excessive working hours beyond the fixed legal limits, *with the assurance that their complaints will be carefully looked into and that they will be fairly dealt with.* It is by this means that the staff are given confidence and contentment in their work, and by which causes of discontent or troubles which may disturb the working of the services may be eliminated.

There is another detail which is also bound up in some respects with the regulation of working hours, and that is as regards holidays, which is a question on which there exists very great diversity between different countries and different administrations.

Holidays, which should be granted independently of periodical days off, are a concession which is very much appreciated by the staff.

The staff, especially on the large railways, are very rarely stationed in their own native districts and generally live a long way from their special interests and from their parents, and it is therefore necessary to give them an opportunity of returning from time to time by means of suitable holidays. The length of this holiday should be therefore longer for those of the staff who in many cases have been moved away from their homes, and on the other hand should be less for the workshop staff or for those who in general work in their native district. It is also well to make a difference in accordance with their length of service and therefore according to age.

To summarise, one may say that the regulation of working hours should be based on principles of equity, both as regards the staff and as regards the railways, and while safe guarding in its essentials the principle of the eight hour day, should allow the greatest flexibility in its application so as not to prevent an efficient output being obtained from the staff and in order to ensure regular working of the service.

APPENDICES.

Appendix I.

Detailed questionnaire relating to question X.

Original rules for applying the eight hour day.

I. — Drivers, firemen and train staff.

1. — Are working hours reckoned at the rate of eight hours per day or at forty-eight hours per week?

2. — What is the maximum interval between two periods of rest?

3. — What is the maximum duration of effective work in the interval between two consecutive uninterrupted periods of rest?

4. — As regards questions Nos. 1, 2 and 3, how are the following reckoned:

a) time during which employees have only to remain present at the shed without being occupied reserve or spare)?
b) time occupied when not at work to proceed from one place to another in order to take duty or in order to return?

5. — Time allowed for the duties which have to be carried out before the departure or after the arrival of trains. Is a definite length of time allowed in each case or is there one uniform allowance, and in the latter case, what is this time in accordance with the class of train worked? Before or after the journey as a passenger (which is dealt with in question 4-*b*), is this reckoned as supplementary time, and if so, at what rate?

6. — What is the minimum period of uninterrupted rest:

a) at home;
b) when lodging out?

7. — What is the minimum amount of weekly time off, and how many days may be worked as a maximum between two consecutive days off?

8. — Between what hours is work considered as night work, and what is the maximum consecutive number of nights which may be worked?

9. — Is there any limit, and if so, what is the limit for the time when absent from home when working trains?

10. — Is there a limit, and if so, what is it, in the hours occupied in working trains between two consecutive uninterrupted periods of rest?

11. — Up to what extent is the time between the arrival of one train and the departure of the same or another train counted as working time?

12. — Are working hours in the case of late running counted in accordance with the timetable or in accordance with the actual time of arrival?

II. — Station and shed staff.

(Traffic and locomotive departments.)

13. — What are the daily working hours (including hours of actual work and periods of presence on duty) for employees of different categories in accordance with the nature, continuity and intensity of the work performed?

14. — What is the minimum uninterrupted daily period of rest:

a) for employees residing close to the station;
b) in other cases?

15. — What is the maximum number of periods into which the working day may be divided?

16. — What is the maximum period of idle time which may be considered as working hours?

17. — How is the weekly day off arranged?

18. — How many consecutive nights on duty are allowed?

III. — PERMANENT WAY EMPLOYEES.

19. — For staff employed in guarding the line, please answer the following questions:

a) daily working hours;
b) minimum daily uninterrupted period of rest;
c) how are weekly days off arranged;
d) maximum number of consecutive nights on duty;
e) how is the work of female gatekeepers organised.

20. — For staff employed in the maintenance of the track, please state:

a) daily working hours in accordance with the seasons;
b) minimum daily uninterrupted period of rest;
c) how is Sunday work arranged;
d) is time off given to the staff for other fete days in addition to Sundays (such as Christmas, etc.);
e) whether and by what means time lost during winter may be made up during the summer;
f) whether and by what means is time spent in walking along the line to and from their daily work reckoned.

IV. — WORKSHOP AND STORES STAFF.

21. — Please give the following for the various categories of workshop and stores staff:

a) daily working hours;
b) whether working hours are as a rule interrupted by a short break, and how long is this;
c) if mechanics and labourers have holiday with pay every Sunday and other fetes (such as Christmas, etc.). In this case are working hours lost during a fete day made up on Sundays?

V. — FOR ALL EMPLOYEES.

22. — What are the special exceptions allowed as regards hours of work and rest?

23. — How are complaints of employees against working hours and conditions dealt with?

24. — Can increased working hours be required as the result of unforeseen or accidental circumstances?

25. — Is it laid down that under no case and under no pretext can employees concerned with the safe working of trains leave their duties on the plea that their hours have been exceeded?

26. — What holidays are employees of various categories allowed in addition to the weekly day off?

27. — Ae there any employees, and if so which, which are not paid for their weekly day off?

Pre-existing rules.

28. — For each of the above questions, please state:

a) hours of work and rest in force before the application of the eight hour day;
b) what is the estimated percentage increase in the staff of various categories as a result of the original application of the eight hour day?

Amendments in the application of the eight hour day.

29. — What amendments have been made up to the present or are proposed in applying the principle of the eight hour day, and what are the advantages obtained or to be obtained?

Note. — Administrations and companies are asked to kindly send to the reporter documents dealing with the regulation of the working hours of their employees, as well as the reply to the above questionnaire.

Appendix 11.

Development of the rules dealing with working hours on the Italian Railways.

(*Staff concerned with the safety of traffic operation.*)

SUBJECT.	Staff.	Rules in accordance with				
		Royal Decree of the 10 June 1900, No. 261.	Royal Decree of the 17 November 1902, No. 477.	Royal Decree of the 20 August 1914, No. 993.	Royal Decree of the 8 June 1919, No. 912.	Royal Decree of the 22 July 1923, No. 1631.
1. *Average daily hours of work*	Engine	About 10 h. 20 m.	About 10 3/4 hours.	10 hours.	(1) 8 hours of presence on duty.	8 hours of effective work.
	Train.	About 11 h. 20 m.	About 11 1/2 hours.	11 hours.	Ditto.	Ditto.
	Station	10 to 12 hours (*a*)	10 to 12 hours (*a*)	8-10-12 hours (*a*).	Ditto.	Ditto.
	Permanent way.	14 hours.	14 hours.	12 to 14 hours (*b*)	Ditto.	Ditto.
2. *Maximum length of working day (between two ordinary periods of rest).*	Engine	17 hours.	17 hours.	17 hours.	12 to 11 hours (*d*)	12 hours (which may be extended to 14 hours in exceptional cases).
	Train.	17 hours (in exceptional cases 19 hours).	17 hours (in exceptional cases 19 hours).	17 hours.	12 hours.	Ditto.
	Station	16 hours.	16 to 17 hours (*c*)	16 to 17 hours (*c*)	14 hours.	15 hours (which may be extended to 16 hours in exceptional cases).
	Permanent way.	17 hours.	17 hours.	17 hours.	14 hours.	Ditto.
3. *Maximum amount of work in working hours (between two ordinary periods of rest).*	Engine	13 hours.	13 hours (in exceptional cases 14 hours).	12 hours (in exceptional cases 13 hours).	8 (7) hours (*e*).	10 (9) hours (*e*).
	Train.	15 hours.	15 hours.	14 hours	8 hours.	10 hours.

period of rest :						
At home	Engine	8 hours (which may be reduced to 7 hours, where compensated for either before or after) (*g*).	9 hours (*g*) which may be reduced to 7 hours by giving longer periods of rest either before or after.	10 hours.	16 hours.	15 hours (which may be reduced to 12 hours after light duty).
	Train.	Ditto (*h*).	8 hours (*h*) ditto.	9 hours.	16 hours.	14 hours (ditto).
	Station	8 to 7 hours (*c*).	8 to 7 hours (*c*).	8 to 7 hours (*c*).	10 hours.	9 hours (which may be reduced to 8 hours under special circumstances).
	Permanent way.	7 hours (*f*).	7 hours (*f*).	7 hours (*f*).	10 hours.	
When lodging out . . .	Engine	7 hours.	7 hours.	7 hours.	10 hours (in exceptional cases 8 hours).	8 hours (which may be reduced to 7 hours with compensation).
	Train.	7 hours.	7 hours.	7 hours.	7 hours.	Ditto.
5. *Periodical days of rest (number per year and minimum duration).*	Engine	12 of 24 hours at least.	24 of 24 hours at least.	24 of 34 hours at least.	52 of 40 hours at least.	52 of 36 hours at least.
	Train.	Ditto.	12 of 32 hours or 18 of 24 hours.	18 of 34 hours at least.	Ditto.	Ditto.
	Station	(*i*).	(*i*).	24 } of 24 hours in addition to ordinary period of rest	52 of 24 hours in addition to ordinary period of rest.	52 of 24 hours in addition to ordinary period of rest with a minimum of 30 hours.
	Permanent way.	...	...	12 }		
6. *Annual holiday with pay (average).* *N. B.* — In accordance with the regulations in force at the date of the decree.	Engine	18	18	18	24	24
	Train.	12	12	12	18	18
	Station	12	12	12	18	18
	Permanent way.	8	8	8	14	14

(1) After complete application of the eight hour day. — (*a*) In accordance with the nature, intensity and continuity of the work. The 8 hours only apply to traffic staff and pointsmen whose work is arduous and uninterrupted. — (*b*) The 12 hours only apply to block signalmen. — (*c*) In accordance with whether the employees residence is near or far from his place of employment. — (*d*) The 11 hours only apply to staff employed on express or similar trains. — (*e*) Exception is made in the case of staff employed on express or similar trains. — (*f*) In addition to the time necessary to proceed to duty or to return. — (*g*) May be increased to 10 hours after 12 hours of work. — (*h*) May be increased to 10 hours after a period of work of 19 hours. — (*i*) The rest period of 24 hours only applies when changing shift.

Appendix II. (Continued)

Development of the rules dealing with working hours on the Italian Railways.

(*Staff concerned with the safety of traffic operation.*)

SUBJECT.	Staff.	Rules in accordance with				
		Royal Decree of the 10 June 1900, No. 264.	Royal Decree of the 17 November 1902, No. 477.	Royal Decree of the 20 August 1914, No. 993.	Royal Decree of the 8 June 1919, No. 912.	Royal Decree of the 22 July 1923, No 1631.
7. *Maximum period of interruption reckoned as work.*	Engine	1 1/2 hours.	1 1/2 hours.	1 1/2 hours.	2 hours.	2 hours.
	Train	1 hour.	1 hour.	1 hour.	2 hours.	1 1/2 hour.
	Station	Less than 1 hour.	Less than 1 hour.	Less than 1 hour.	Less than 1 hour.	Less than 1 hour.
	Permanent way.	...	...	...	...	...
8. *Counted as work:* a) *available for duty at home;*	All	At one quarter rate (for footplate and train staff).	At one quarter rate (for footplate and train staff).	At one quarter rate (for footplate and train staff).	At full rate.	At two-thirds rate.
b) *travelling as passengers to take duty or returning;*	Engines and trains	At full rate.	At full rate.	At full rate, plus 30 minutes per journey.	At full rate, plus 30 minutes per journey.	At two-thirds rate.
c) *as reserve or available when lodging out.*	Engines and trains	At half rate.	At half rate.	At half rate.	At half rate.	At half rate.
9. *Maximum mileage in an uninterrupted period of work.*	Engine	...	..	...	250 km. (155 miles).	...
	Train	...	...	...	200 km. (125 miles).	...
10. *Maximum time absent from home.*	Engine	...	...	...	28 hours.	...
	Train					
11. *Period reckoned as night work.*	All	...	From 2.0 a. m. to 3.30 a. m.	From 1.0 a. m. to 4.0 a. m.	From midnight to 5.0 a. m.	From midnight to 5.0 a. m.
12. *Maximum number of consecutive nights on duty.*	Engine	...	6 (if occupied in shunting).	6	4	4
	Train	..	No limits.	7		
	Station	7	7	7	7	6
	Permanent way.	...	...	...	...	...

Appendix 111.

Staff of the State Railways.

DATES.	Total number of employees [1].	From which must be deducted		Staff employed by the operating departments.	Train mileage in thousands of kilometres (thousands of miles).	Number of employees per thousand train-kilometres (per thousand train-miles).	Increase (per thousand train-kilometres) in the staff compared with the years 1913-14 as a percentage.
		staff concerned with water borne traffic.	not connected with the operating departments.				
30 June 1914.	154 985	1 032	6 071	147 882	118 885 (73 873)	1.25 (2.01)	...
— 1915.	152 649	1 511	5 711	145 427	110 495 (68 660)	1.32 (2.12)	5 6
— 1916.	157 873	2 838	5 372	149 663	117 194 (72 822)	1 28 (2.06)	2.4
— 1917.	162 942	2 979	5 558	154 405	117 076 (72 749)	1.32 (2.12)	5.6
— 1918.	157 368	2 462	3 807	151 099	92 135 (57 251)	1.64 (2.64)	31.2
— 1919.	188 236	3 195	5 119	179 922	93 967 (58 389)	1.91 (3.07)	52 8
— 1920.	222 699	(2)	5 408	217 291	97 770 (60 753)	2.22 (3.57)	77.6
— 1921.	236 890	(2)	6 382	230 508	102 757 (63 851)	2.24 (3.60)	79.2
— 1922.	228 423	2 219	5 033	221 171	112 661 (70 005)	1.96 (3.15)	56.8
— 1923.	207 019	961	3 409	202 649	113 464 (70 504)	1.79 (2.88)	43.2
— 1924.	175 645	765	3 181	175 645	114 025 (70 853)	1.54 (2.48)	23 2

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[1] Including secondary railways in Sicily. (According to the annual report of the State Railways Administration.)

[2] Water borne traffic was not dealt with by the State Railways.

Appendix IV.

Decree of the Lieutenant-General of the Kingdom, No. 912, of the 8 June 1919, bringing into force the eight hour day and weekly day of rest for employees of the State Railways, the Minister of Transport to fix details of its application and the date on which it shall come into force.

Thomas de Savoie, Duke of Genoa,
Lieutenant-General
to His Majesty Victor Emmanuel III,
by the Grace of God
and by the will of the Nation,
King of Italy :

In virtue of the powers delegated to us in accordance with;

Article 1 (last line) of the Decree of the Lieutenant-General, No. 1393, of the 13 August 1917,

And in accordance with the advice of the Ministers,

On the proposition of the Minister of Marine and Railway Transport, and in agreement with the Minister of Finance;

It is decreed :

Article 1. — That the application of the eight hour day and weekly rest shall be established for the staff of the Administration of the State Railways, with exceptions which shall be fixed by the Minister of Marine and Railway Transport, having regard to the different conditions of service of the various categories and groups of employees.

Article 2. — For the categories or groups of employees who are excluded from the application of the eight hour day, a reduction in the present hours of work may be authorised in drawing up the working times and regulations.

Article 3. — The methods of applying the regulations above mentioned and the dates on which they are to come into force will be fixed by the Minister of Marine and Railway Transport, having regard to the technical difficulties in connection with putting these measures into force and the necessity of ensuring continuity and regularity in traffic operation.

Article 4. — The provisions of this Decree shall come into force on the 15 June 1919.

We command that this Decree, with the State Seal duly fixed, shall be filed among the official laws and Decrees of the Kingdom of Italy, to be duly observed and enforced.

Rome, 8 June 1919.

Thomas de Savoie,

Approved :
Keeper of the Seal,
Facta.

Colosimo, De Nava,
Stringher.

Appendix V.

Royal Decree of the 22 July 1923, No. 1631, dealing with working hours of the staff of the State Railways.

I. — General regulations.

Article 1. — The average length of working hours shall not exceed eight per day, or forty-eight per week.

2) The following will be reckoned as hours of work :

a) time employed in carrying out any authorised work, whatever is the nature;

b) two-thirds of the time during which employees have merely to remain continuously on duty while waiting in readiness or guarding the line.

3) The following are not counted as hours of work:

a) intervals of an hour or more during which employees are allowed to leave their place of employment;
b) time occupied in proceeding to work or returning therefrom;
c) time employed in travelling in order to take duty or when returning therefrom.

ARTICLE 2. — 1) In each period of twenty-four hours, duty shall be arranged in such a way as to normally allow an uninterrupted period of rest of at least nine hours.

2) The length of a period of rest may be reduced to eight hours when changing shift or after particularly light duties. The difference between eight and nine hours rest will be compensated after or before the reduced period of rest or by break during working hours.

3) The length of time on duty including both hours of effective work and presence on duty should not exceed twelve hours between two uninterrupted periods of rest.

4) When the duties are carried out by a number of employees in rotation, the length of working hours may be extended to twelve hours between two uninterrupted periods of rest, provided that the additional hours shall be compensated for either before or after this is done.

5) No latitude is allowed in the length of working hours.

ARTICLE 3. — 1) Employees are to be allowed a weekly rest day, the length of which shall be normally twenty-four hours, in addition to the rest periods laid down in the preceding article. This period of rest may be reduced to a minimum of thirty hours when it is necessary to change shift.

2) If service conditions allow, the weekly day of rest should preferably be given on Sunday.

3) During the weekly day of rest, employees may leave their homes, except in cases where it shall be required that they shall be available at home.

4) Weekly days of rest occurring in a period of absence (holidays, sick leave, etc.) shall be included therein.

ARTICLE 5. — 1) For staff concerned in the carried out by two or more than two employees by alternate shifts, these shall not as a rule be required to work on night duty for more than six consecutive nights.

2) Night duty is work carried out wholly or partially between mid-night and 5.0 a. m.

ARTICLE 5. — 1) For staff concerned in the running of trains, their duties and working hours shall be drawn up in accordance with the timetable to which these trains run.

2) A copy of the working hours and regulations shall be posted before they come into force, at a suitable place, so that all employees concerned may be conversant with the same.

II. — **General regulations.**

(Drivers, firemen, electric train drivers, chief-guards, guards and brakesmen employed on trains.)

ARTICLE 6. — *Footplate and train staff.*

1) The length of working hours between two normal periods of rest shall not as a rule exceed ten hours; this limit may be reduced to nine hours for staff employed on express or similar services.

2) The hours of work consist of the following:

a) the length of time during which the staff are waiting between arriving of the train (counting from actual time in the case of late running) and departing with the same train or with another train, when this standing time between two journeys on duty does not exceed two hours for footplate staff and ninety minutes for train staff;
b) two-thirds of the time occupied in tra-

velling as passengers to join the train in order to take duty or when returning therefrom;

c) half the time waiting as spare or available away from home.

3) The minimum normal period of rest shall be fourteen hours (fifteen for footplate staff) at home, which may be reduced to twelve hours if the period of rest is preceded by a period of work not exceeding six hours (five for footplate staff), or eight hours when lodging out, which may be reduced to seven, provided that this reduction shall be compensated, either before or after, preferably when at home.

4) Between two normal consecutive periods of rest, there shall not be an interval of more than twelve hours, this time including hours worked, short intermittent periods of rest and periods when in reserve or spare. This limit may be increased up to fourteen hours when the hours worked which are included do not exceed eight hours or when it includes periods of rest of four hours or more.

5) The length of the weekly day of rest for the staff referred to in this article should not be less than thirty-six hours.

6) In applying above paragraphs 1 and 4, no account is taken of time spent travelling as passengers to return home for ordinary or weekly periods of rest.

7) In a period of seven consecutive days, nights on duty shall not be more than four.

ARTICLE 7. — *Permanent way staff.*

1) The working hours of members of the permanent way maintenance staff are fixed in accordance with the seasons and locality : they shall range from a minimum of seven and a half hours up to a maximum of ten hours.

2) The weekly day of rest shall as a rule be taken by employees refered to in the above paragraph on Sunday, during which day only one man shall be on duty, and half of each gang shall remain available at home.

3) When the duties of permanent way watchmen are partially carried out by female gatekeepers, these shall not be employed on night duty, which shall only be carried out by men.

ARTICLE 8. — *Repair shop staff.*

1) The working day is generally divided by a break of at least two hours. In view of local conditions, this break may as an exceptional case be reduced to half an hour for a meal to be eaten without leaving the workshop.

2) Workshops are as a rule closed on Sunday, and the staff are free during the whole day.

ARTICLE 9. — *Office staff.*

1) For the office staff of not less than grade 12 (chief messengers and messengers excluded) the daily working hours are seven, divided as a rule into two periods by a break of at least two hours.

Where special local conditions exist, this break may be reduced to a minimum of half an hour.

2) The staff is free on all Sundays throughout the whole of the day. On other civil fete days, half of the staff are on duty during half the day, this being taken in turns. They may be allowed off for half a day at other fetes as decided by the General Manager.

III. — **Exceptions.**

ARTICLE 10. — 1) As the result of exceptional circumstances or of the exigencies of the service, the staff may be required to work beyond the established limits, for which they will be compensated, either before or after the special hours have been worked, or will be paid in accordance with the regulations in force.

2) The management, wherever possible, will relieve employees who may as the result of these increased working hours have a period of rest less than that laid down in the preceding articles.

3) In no case may employees leave their duties without being relieved on the plea that their working hours have been completed.

4) As the result of exigencies of service or

from difficulties in arranging working hours, the weekly day of rest may be postponed for one or two days.

5) In very busy periods, or when as the result of exceptional circumstances, the weekly day of rest may, except in the case of footplate and train staff as laid down in article 6, be taken either one month or more before or after. In this case time off may be taken two days at a time, the total time off being equal to the length of the first period increased by twenty-four hours.

6) The weekly day off will be taken as a rule at home. It may, however, be taken by employees when lodging out in cases where they are employed continuously at a considerable distance from their homes.

IV. — Complaints and claims.

ARTICLE 11. — 1) The detailed regulations for applying this law will be approved by the General Manager.

2) Complaints and claims on the part of the staff against working hours and regulations are to be addressed through the proper channel to the respective chiefs of the section of the traffic department or workshop, inspector of supplies or sanitation, or to the chief of the office, who, after looking into the same, shall communicate his decision to those concerned.

3) If not satisfied with this decision, employees may take the matter to the head of the department in cases where they belong to the departmental head quarters, or to the traffic committee in other cases. The chiefs of the departments and the traffic committees shall make the final decision, and no appeal is allowed against this decision.

ARTICLE 12. — The foregoing regulations shall come into force on the date of their publication in the Bulletin of the State Railways, which at the same time cancels the Decree of the Lieutenent-General of the Kingdom, No. 912, of the 8 June 1919, and all other regulations

This present Decree is to be laid before parliament for ratification.

Rome, 22 July 1923.

Appendix VI.

Royal Decree of the 19 October 1923, No. 2328, containing regulations for fixing hours and conditions of service for the staff employed in the public transport services conceded by the Government.

(Including the modifications contained in the Royal Decree, No. 2682, of the 2 December 1923.)

I. — General rules.

ARTICLE 1. — *Effective work.*

For the purposes of the present regulations, a distinction is to be made between effective work and non-effective work.

Effective work is work of any kind which requires constant uninterrupted application. Non-effective work is work which is interrupted or in cases which merely entail being present on duty or in guarding the line, or any other work of whatever kind which is not constant and uninterrupted.

ARTICLE 2. — *Maximum normal working hours.*

The average normal working hours per day shall not exceed eight hours of effective work.

ARTICLE 3. — *Overtime.*

It is authorised, in cases where the parties concerned agree, to increase the normal hours of work as fixed in article 2, by an additional period of two hours per day as a maximum, or for time which over a given period shall have the same average, subject to the condition in every case that overtime shall be reckoned separately and paid for at an increased rate at least 10 % greater than the normal rate of pay and with a corresponding increase in the case of piece-work.

ARTICLE 4. — *Temporary exceptions agreed to by the staff.*

The Minister of Public Works may authorise departures from the above rules in the case of special work.

ARTICLE 5. — *Duration of working hours.*

The total hours of effective work, the actual hours of non-effective work, and hours of overtime, shall form the duration of working hours.

ARTICLE 6. — *Night work.*

Night work is that carried out either wholly or partially between mid-night and 5.0 a. m.

Where the duties are carried out by two or more than two employees who change shifts, these shall not as a rule be on night duty for more than six consecutive nights.

ARTICLE 7. — *Commencement and end of work.*

The time necessary for changing clothes, washing, taking over duties and receiving instructions at the commencement of work shall not be reckoned as effective work, but simply as time present on duty.

ARTICLE 8. — *Unforeseen exceptional cases.*

As the result of weather conditions, accidents or exceptional circumstances, all the staff are required to extend their working hours beyond the limits laid down, provided that this does not lead to less than seven hours rest out of twenty-four. In this case, the effective work over and above the average of eight hours per day will be paid for as overtime and compensated for by equivalent periods of rest.

ARTICLE 9. — *Unavoidable circumstances and imminent danger.*

The duration of working hours may be increased beyond the limits laid down in the preceding articles in the case of unavoidable circumstances, or where cessation of work might constitute danger or damage to life and limb or to the safety and regularity of traffic movements.

Such extensions will be reported by the head of the traffic department to the Minister of Public Works (Inspector General of Railways and Tramways).

ARTICLE 10. — *Publication of rules.*

The Administrations shall be compelled to display in the offices, stations, engine sheds and workshops, the rules of the service, so that the staff may be acquainted with the same.

ARTICLE 11. — *Complaints and claims.*

The present regulations allow the staff the right to bring any complaints before the Chief Inspector of Railways, who, after having heard both sides of the complaint, shall make a decision which is binding.

Infringements of the rules of this present Decree on the part of the railway Administrations render them liable to the fines laid down by article 59 of the regulations, No. 1687, of the 31 October 1873, as amended by Royal Decree, No. 145, of the 22 March 1900, and by article 9 of Royal Decree, No. 692, of the 15 March 1923.

II. — **Footplate staff.**

(Enginemen, firemen and drivers of inter-urban railways and tramways.)

ARTICLE 12. — *Method of reckoning effective work.*

The following is reckoned as effective work:

a) The time necessary to work trains, counting from the time when the staff are required to sign on at the shed or at the station to take over an engine, up to the time that they are authorised to leave the same, including standing time, the length of which is not more than half and hour;

b) time employed in shunting or banking duties;

c) time occupied at the shed for all other work on an engine, and time during which the staff have to be present on the engine to prepare it for work;

d) time occupied on additional duties which cannot be defined, is to be reckoned as an equivalent amount of effective work at a rate ranging from a quarter to a half in accordance with the nature and importance of this work;

e) half the time employed in travelling as passengers from one place to another to take duty or to return after the completion of the same;

f) quarter of the time spent in reserve at a shed or station during which the staff are not required to remain on the engine, and also time during which the staff have to remain available at the shed.

The duties given under letters *d*, *e*, and *f*, which are reckoned as equivalent to a reduced amount of effective work, are on the other hand reckoned in full as regards the duration of working hours, provided for in article 14 which follows.

ARTICLE 13. — *Average daily amount of work.*

The average daily amount of effective work, calculated as given above, should not, for one turn of duty, or for a series of turns of duty, comprising as a maximum one periodical period of rest, including days in reserve and periods of rest mentioned hereafter, exceed eight hours, with a maximum of fifty-two hours effective work per week.

ARTICLE 14. — *Duration of working hours.*

In each period of twenty-four hours made up in any way in the course of a turn on duty, the duration of working hours, calculated in accordance with article 12, shall not exceed thirteen hours. However, when this period exceeds twelve hours, each of the two periods of uninterrupted rest between which this period of work is calculated should have at least a duration of ten hours.

ARTICLE 15. — *Daily rest.*

Footplate staff are allowed periods of rest each having a duration of ten hours if they are taken at home, and eight hours when lodging out, utilising in the second case, if necessary, periods when waiting as spare or available, as laid down in article 12, letter *f*).

When service conditions make it necessary, the hours of rest at home may, with the approval of a competent inspector, be reduced to seven hours at home, provided that compensation is made either before or after this is done. In every case the succeeding period of rest should be taken at home, should be uninterrupted and be for eleven hours at a minimum.

Uninterrupted periods of rest should be separated by intervals (effective work, non-effective work, overtime, short periods of rest, etc.), the length of which may be fourteen hours at the most; in each turn of duty there shall be at least a number of rest periods equal to the number of days in this turn. The limit of fourteen hours may be increased to sixteen hours, when the work included therein does not exceed eight hours, or where it is divided by a period of rest of at least four hours.

When it is not possible to grant ten hours rest at home, the difference may be compensated by increased periods of rest before or after this has been done, even by time allowed off; however, the working day must not fall below eight hours.

ARTICLE 16. — *Periodical days off.*

In the periods of rest at home, mentioned in the preceding article, there shall be fifty-two periodical days off per year, the length of which shall be twenty-four in addition to the regulation holidays, subject however to the dispositions of article 42 in appendix A to the Royal Decree, No. 2311, of the 19 October 1923.

III. — **Train staff.**

(Chief guards, guards, brakesmen, drivers and conductors of urban tramways.)

ARTICLE 17. — *Method of reckoning effective work.*

The following is reckoned as effective work:

a) the time employed on duty in accordance with the booked time of trains, including time standing at stations, during which, if necessary, the staff have to carry out shunting or the handling of goods conveyed by train;

b) the time necessary for additional work, which is reckoned on a fractional basis ranging from one half to one quarter in accordance with the nature and importance of this work;

c) half the time occupied in travelling as passengers from one place to another in order to take duty or to return after having completed duty;

d) quarter of the time where the employee remains in reserve at the station or sidings available if he is required.

Duties coming under letters *b*, *c* and *d*, which are reckoned on a fractional basis, to be the equivalent of effective work, are on the other hand reckoned in full as regards the duration of working hours dealt with in article 29 which follows.

Article 18. — *Average daily hours of effective work.*

In one turn of duty or in a series of turns including at least one intermediate periodical day of rest, including days as spare and the periods of rest given above, the average daily hours of effective work shall not exceed eight hours with a maximum of fifty-two hours of effective work per week.

Article 19. — *Length of working hours.*

In each period of twenty-four hours, reckoned from any time in accordance with the turn of duty, the duration of working hours, reckoned in accordance with article 17, should not exceed fifteen.

However, when the working hours exceed fourteen, each of the two rest periods between which this work is done should have a duration of at least ten hours.

Article 20. — *Daily rest.*

The periods of uninterrupted rest allowed to the staff shall be ten hours at least when taken at home, and eight hours when lodging out.

When by reason of exigencies of the service, authorised by competent authority, renders it necessary to reduce the rest period when lodging out, this may be seven hours, provided that compensation is made either before or after the exceptional circumstances occur, and in any case provided that the following period of rest is taken at home and that it is of at least eleven uninterrupted hours.

Uninterrupted periods of rest may be separated by intervals (effective work, non-effective work, overtime, short rest periods, etc.) the length of which shall not exceed fifteen hours and should in each turn of duty be at least equal in number to the number of days in the turn of duty.

However, in the case of work which is interrupted by one or more periods of inaction, the total length of which is at least four hours, the interval between two uninterrupted periods of rest may be, in exceptional cases, extended up to sixteen hours. In this case the next period of rest shall be at least ten hours.

If it is not possible to give ten hours of rest at home, the difference shall be made up either before or after the exception case by longer periods of rest, or even by time off. It should not, however, be less than eight hours.

Article 21. — *Periodical days of rest.*

Of the uninterrupted periods of rest at home referred to in the preceding article, there shall be fifty-two periods per year of twenty-four hours, in addition to the statutory holidays, having regard, however, to the provisions of article 42 of the regulations shewn in appendix A to Royal Decree, No. 2311, of the 19 October 1923.

IV. — **Station staff.**

(Station masters at passenger and goods stations, traffic staff, storekeepers, telegraphists and telephone operators, shunters, signalmen, porters, etc.)

Article 22. — *Method of reckoning effective work.*

The following is reckoned as effective work:

a) shunting;

b) the duties of signalmen, traffic staff, goods warehousemen, booking clerks, telegraphists, or porters and loaders employed at stations or docks where trains or boats depart or arrive at intervals of less than thirty minutes;

c) duties in connection with power stations or hydraulic machinery or in working lifts;

d) half of the time during which the employee is unoccupied but has to remain on duty.

In order to calculate the duration of working hours, as dealt with in article 24, the time included under paragraph *d* is reckoned in entirety.

ARTICLE 23. — *Average daily hours of effective works.*

In one turn of duty in a series of turns including at least one intermediate periodical day of rest, including days as spare and the periods of rest given above, the average daily hours of effective work, calculated in accordance with the rules given above, shall not exceed eight hours where the work is of a heavy nature or a limit ranging from nineteen to twelve hours under conditions of work of a lighter nature when there are breaks in employment, the total length of which is from two to four hours respectively, with a maximum of fifty-two and sixty-five or seventy-eight hours respectively of work per week.

ARTICLE 24. — *Length of working hours.*

In each period of twenty-four hours, reckoned from any time in accordance with the turn of duty, the duration of working, reckoned in accordance with article 22, should not exceed sixteen.

ARTICLE 25. — *Daily rest.*

In each period of twenty-four hours the staff are allowed a period of uninterrupted rest of seven or eight hours, in accordance with whether the employees place of residence is in the precincts of the station or otherwise.

When by reason of exigencies of the service, authorised by competent authority, renders it necessary, the uninterrupted period of rest may be seven hours for all employees without exception, provided that the additional work done is reckoned as overtime.

ARTICLE 26. — *Periodical days of rest.*

Of the uninterrupted periods of rest at home, referred to in the preceding article, there shall be fifty-two periods per year of twenty-four hours, in addition to the statutory holidays, having regard, however, to the provisions of article 42 of the regulations shewn in appendix A to Royal Decree, No. 2311, of the 19 October 1923.

V. — **Permanent way staff.**

(Inspectors, gangers, platelayers, watchmen, gatekeepers' mechanics and labourers.)

ARTICLE 27. — *Method of reckoning effective work.*

The following is reckoned as effective work:

a) the time necessary to carry out work connected with upkeep, of the track, buildings, or of bridges, tunnels, etc., commencing from the time at which employees have to meet at a given place, not including the time taken in changing clothes or in meals eaten at their place of employment;

b) half the time during which they have to be present at level crossings during the passing of trains or for inspecting or guarding the line,

Duties which are included in paragraph *b* which are only reckoned in part when calculating the effective work are, on the other hand, reckoned in entirety as regards the duration of working hours dealt with in article 29.

ARTICLE 28. — *Average daily hours of effective work.*

In one turn of duty in a series of turns including at least one intermediate periodical day of rest, including days as spare and the periods of rest given above, the average daily hours of effective work, calculated in accordance with the rules given above, shall not exceed eight hours with a maximum of fifty-two hours of effective work per week.

When by reason of weather conditions, unforeseen occurrences, or inability to work due to the season of the year, or where eight hours effective work during the day is impossible, the hours of work which are thereby lost shall be made up without any extra pay, provided that the maximum day of ten hours work is not exceeded.

ARTICLE 29. — *Length of working hours.*

In each period of twenty-four hours, reckoned from any time in accordance with the turn of duty, the duration of working hours, reckoned in accordance with articles 27 and 28, should not exceed fourteen.

On lines where lengthmen also fulfil the duties of permanent way watchmen, the period of work reckoned as above shall not exceed thirteen hours made up by short periods during the day and night.

When the duties of guarding the line are partially carried out by female gatekeepers, these should not be required to work on night duty, which shall be carried out exclusively by the male staff.

The working hours of female gatekeepers should not exceed twelve, with an uninterrupted nightly rest of at least ten hours, which may be reduced to nine hours during the summer.

ARTICLE 30. — *Daily rest.*

The staff are allowed a daily uninterrupted rest of at least eight hours. As regards the staff which also carry out the duties of guarding the line, the rest period should not be less than nine hours.

When the exigencies of the service authorised by competent authority exist, the period of uninterrupted rest may be reduced to seven hours, provided that it is made up by another period of uninterrupted rest of two hours during the day.

ARTICLE 31. — *Periodical days of rest.*

Of the uninterrupted periods of rest at home, there shall be fifty-two per year of twenty-four hours, in addition to the statutory holidays, having regard, however, to the provisions of article 42 of the regulations shewn in appendix A to Royal Decree, No. 2311, of the 19 October 1923.

VI. — Miscellaneous staff.

(Switch board operators, linesmen, etc.)

For employees such as linesmen employed on telegraph and other electrical installations, who by the nature of their duties have to visit various localities, the time employed in travelling by train as passengers is reckoned at half rate in arriving at the effective work, and time spent walking along the line is reckoned at one hour of effective work for every 2.5 miles walked going or returning.

The length of hours on occupations which consist only of being present on duty, such as switch board operators at electric power stations and sub-stations, night watchmen, caretakers, and watchmen in general, even when employed during the night, is only reckoned at two-thirds in order to calculate the equivalent effective work.

ARTICLE 33. — *Average daily hours of effective work.*

The average daily hours of effective work for all the regular staff, even where this is not included in that dealt with in the preceding articles, in a turn of duty or in a series of turns of duty, including at the most one intermediate periodical day of rest, including days as spare and periods of rest given below, shall not exceed eight hours with a maximum of fifty-two hours of effective work per week.

ARTICLE 34. — *Periodical days of rest.*

All the regular staff employed, including those not mentioned in the preceding articles, shall have in each year fifty-two uninterrupted periods of rest of twenty-four hours each at their homes, not including the statutory holidays, having regard, however, to the provisions of article 42 of the regulations shewn in appendix A, to the Royal Decree, No. 2311, of the 19 October 1923.

Approved by order of H. M. the King:
The Minister of Public Works,
(Signed) CARNAZZA.

Appendix VII.

Swiss Federal law of the 6 March 1920 dealing with the working hours on railways and other means of transport and communications.

The Federal Assembly of the Swiss Confederation.

In view of articles 26 and 36 of the Federal Constitution;

And in view of the note of the Federal Council of the 16 June 1919,

the following provisions are enacted:

ARTICLE 1. — *Scope of application.*

1. The following are subject to this act:

a) the Federal Railways;

b) the Postal Administration;

c) the Telegraph and Telephone Administration;

d) transport and communication concerns conceded by the Confederation.

2. The Federal Council is authorised to also bring within the scope of this act accessory services which form a necessary addition, or even a useful addition to any of the enterprises mentioned in the first paragraph.

3. The law is applicable to persons permanently employed and devoting the greater part of their time to the service of one of the above mentioned concerns, and who are directly employed thereby.

4. Persons occupied in new construction work or in associated works are not subject to the law, except in cases where they are concerned with the safety of the service.

5. Detailed instructions lay down the manner in which this law is to be applied or in which certain of its provisions shall be applied to persons who although directly employed by the concerns in question, are not on the permanent staff or do not devote the greater part of their time to one of the concerns dealt with by this present act.

6. Legislation as regards factories is still pending.

ARTICLE 2. — *Working day.*

1. The working day within the meaning of the act consists of turns of duty and turns of rest.

2. A turn of duty is the time between commencing work after a turn of rest and the following turn of rest; it is composed of hours of work and of breaks.

ARTICLE 3. — *Hours of work.*

1. The daily hours of work should not exceed eight on the average in a period of fourteen days at the most, either consecutively or separated by single days of rest.

2. The average hours of work may be increased to nine hours in the case of occupations which consist largely in merely being present on duty; these occupations should be laid down in the instructions.

3. The length of working hours, overtime included, shall not exceed ten hours in one turn of duty. Equivalent time off should not be given where overtime is paid for work done in addition to the regular hours. Overtime is paid on a basis of wages or salary increased by at least 25 %. The employee cannot demand overtime in lieu of time off for more than 150 hours per year.

4. When the maximum length of working hours fixed by law is exceeded by more than a quarter of an hour in consequence of late running of trains, or by unavoidable circumstances, time off should be given, in compensation for the additional hours, during the three following working days.

ARTICLE 4. — *Breaks.*

1. The staff are allowed to have, in the middle of their working hours, a break of at least one hour, during which employees may return to their homes if circumstances permit.

2. This break may be dispensed with if a turn of duty does not exceed eight hours and if it possible for the staff to eat their food during the time they are working.

ARTICLE 5. — *Turns of duty.*

1. The daily length of a turn should not in a period of fourteen days at the most, either consecutive or separated by single days of rest, exceed thirteen hours on the average or thirteen and a half if the employee lives close to the place of his employment. It should be reduced to twelve hours on the average when circumstances allow.

2. The maximum length of a turn on duty, including overtime, is fourteen hours.

3. When special circumstances arise, as laid down in the instructions, the turn of duty may be increased to fifteen hours, provided that the average length during three consecutive days does not exceed the average statutory length laid down in the first paragraph of the present article.

4. When the maximum length of a turn of duty as fixed by law is exceeded by more than one quarter of an hour in consequence of the late running of trains or by other unavoidable circumstances, time off should be given, in compensation for the additional hours, during the three following working days.

ARTICLE 6. — *Periods of rest.*

1. The average daily length of a period of rest should not, in a group of fourteen days at the most, either consecutive or divided by separate days of rest, be less than eleven hours on the average or ten and a half hours if the employee lives in close proximity to his place of employment. It should not be reduced below twelve hours on the average, except in very urgent ceses.

2. The minimum duration of a period of rest is ten hours.

3. Where special circumstances exist, as laid down in the instructions, the period of rest may be reduced to nine hours, provided that its average length during three consecutive days shall not be less than the average statutory period fixed in the first paragraph of the present article.

4. Rest should be taken at home if service conditions allow.

ARTICLE 7. — *Night duty.*

1. Night duty it that performed between 11.0 p. m. and 5.0 a. m.

2. No employee should be on night duty for more than seven consecutive nights nor more than fourteen times in four weeks. This rule is not applicable to turns of duty in the cases where the beginning or the end does not encroach by more than one hour on the period which is considered as night duty; this does not apply to employees who are engaged exclusively for night duty.

ARTICLE 8. — *Female staff.*

1. The instructions may contain certain restrictions as regards the employment of female staff.

2. During the six weeks after their confinement, women should not be employed by transport or communication concerns which come under the present act.

ARTICLE 9. — *Days of rest.*

1. Every employee working under the conditions laid down in the first article, paragraph 3, shall be entitled, during a civil year, to fifty-six days of rest conveniently distributed, of which at least twenty shall be on a Sunday or on a general fete day.

2. For employees of certain categories on secondary railways, employed on water or road transport, the Federal Council may reduce to twelve the number of days of rest which shall be taken on a Sunday or on a general fete day.

3. A day of rest shall consist of twenty-four hours; the employee should be able to spend this at his home.

4. The day of rest shall be preceded, either immediately or closely, by a period of rest

of at least nine hours. The average length of these periods of rest in a period of six weeks at the most should be at least ten hours for employees occupied exclusively on duties between 5.0 a. m. and 11.0 p. m., and twelve hours at least for other employees. Only one such period of rest shall be taken when the employee is about to have two or more consecutive days of rest.

5. Periods of rest of at least twenty-eight hours may be counted as half days of rest in the case of employees who change over from evening or night duty to day or morning duty.

6. If on a Sunday or general fete day a turn of duty does not extend beyond mid-day, the remainder of the day may be counted as a half day of rest, provided that the turn of duty is not longer than five hours and that the period of rest taken immediately after the turn of duty be at least eighteen hours up to the beginning of the next turn of duty.

Article 10. — *Holidays.*

1. Every employee working under the conditions laid down in the first article, paragraph 3, is entitled to the following holidays during the civil year:

7 days during the first seven years of service;

14 days after eight years of service or at the age of 28;

21 days after fifteen years of service or at the age of 35;

28 days after attaining the age of 50.

2. Each period of seven days holidays includes one of the days of rest laid down in article 9.

3. In determining the number of years of service, the whole of the time passed by an employee in connection with transport or communication concerns under the scope of the present act shall be taken into consideration.

Article 11. — *Special rules concerning days of rest and holidays.*

The instructions shall stipulate in detail:

a) the way in which absence for cases of sickness, accidents, military service, or other reasons may affect days of rest and holidays;

b) distribution of holidays.

Article 12. — *Rules.*

1. The instructions shall lay down in detail the approved forms for the table of rules of working days, duties, days of rest and holidays, to be prepared by the administrations.

2. The staff should be consulted before definitely fixing the rules.

Article 13. — *Reduction of goods traffic on Sundays and fete days.*

1. Goods traffic is forbidden on Sundays and also on general fete days (New Year, Good Friday, Ascension Day and Christmas). However, the Federal Council may at any time authorise the running of certain freight trains and also the acceptance of transport and delivery of animals and goods of perishable nature.

2. The cantons may fix four other fete days per year during which the acceptance or delivery of goods is forbidden, with the exceptions stated above.

Article 14. — *Lodging out.*

1. Wherever possible the administrations shall place at the disposal of the staff who cannot return home during the breaks and periods of rest, or who have to take their meals close to their place of employment, shelters with warming apparatus and provided with means for cooking food.

2. Places of work, shelters for breaks and periods of rest, and also lodging houses belonging to the administration should be provided with sanitary conveniences. Lodgings and shelters should moreover be as comfortable as may be reasonably expected.

Article 15. — *Guarantee of wages and salaries.*

1. Administrations are required to pay wages for the days of rest and holidays laid down in the present act.

2. No reduction may be made in view of the concessions given to the staff by the present law in the wages or salaries as reckoned per civil year. The staff may not demand, by reason of the concessions, an increase in pay.

ARTICLE 16. — *Special exceptions.*

1. When special circumstances make it necessary, the Federal Council may, after having discussed the matter with the staff concerned, authorise departures from the present act.

2. Facilities should in particular be given to secondary railways as regards the length of working hours, turns of duty and periods of rest, and also as regards days of rest.

ARTICLE 17. — *Supervision.*

1. The Federal Council will enforce the execution of the obligations imposed on the administrations by the present act.

2. It will issue detailed instructions as regards the exercise of this supervision, and also on the procedure to be followed in the case of complaints on the part of the staff against any infringements of the regulations of this act or its executive instructions.

ARTICLE 18. — *Consultative committee.*

1. The Federal Council shall nominate, for each Federal administrative period, after having received nominations from the administrations and from the staff, a committee composed of a president and from ten to fourteen members. The transport and communication administrations within the scope of the present act and their staff shall be represented in equal numbers on this committee.

2. The committee is empowered in particular to make recommandations on suggested executive regulations, and also on any question which may call for action on the part of the Federal Council as regards passing acts of a general nature, making decisions on disputes or complaints, or in enforcing penal measures.

ARTICLE 19. — *Penalties.*

1. The Federal Council may punish infringements of the present act by a fine up to five-hundred francs, and up to one thousand francs for subsequent offences.

2. The administration is still bound by this act, even if the staff have declared that they do not accept it.

ARTICLE 20. — *Execution of the act. Cancelling of previous regulations.*

1. The Federal Council is entrusted with carrying out the present act and with fixing the date on which it comes into force.

2. If the administrations are obliged, as the result of this act, to increase the number of staff employed permanently and during the greater part of their time, the Federal Council will on demand allow them a reasonable period to conform with the provisions of the act.

3. The present act cancels that of the 19 December 1902 as regards working hours on transport and communication concerns.

As decreed by the State Council.

Berne, 6 March 1920.

The President,
Dr. PETTAVEL.

The Secretary,
KAESLIN.

As decreed by the National Council.

Berne, 6 March 1920.

The President,
E. BLUMER.

The Secretary,
STEIGER.

The Federal Council decided :

1. — That the above Federal law passed by popular vote on the 31 October 1920 shall be inscribed in the *Archives of the Confederation* and shall come into force as follows:

a) the 23 November:

Article 18 (consultative committee) and article 20 (execution of the act);

b) the 1 January 1921:

Article 1 (scope), article 9 (days of rest) with the exception of paragraph 4, article 10 (holidays) and article 16 (special exceptions);

c) on the date of the next change in the timetable, the 1 June 1921 at the latest:

all the other provisions of the act.

2. — The decisions of the Federal Council of the 25 June 1919 making a provisional reduction in the working hours on railways and other transport and communication concerns (*Recueil off.*, XXXV, 485) will remain in force until the date given under paragraph 1, letter *c*, given above.

Berne, 23 November 1920.

By order of the Swiss Federal Council:

The Chancellor of the Confederation,
STEIGER.

[385. (06.111]

1 APPENDIX :
List of the Permanent Commission and the Local organising Committee of the tenth session (London, June 1925).

OFFICIAL INFORMATION

ISSUED BY THE

PERMANENT COMMISSION

OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION.

Meeting of the Permanent Commission held on the 28 February 1925

The Permanent Commission of the International Railway Congress Association met on the 28 February last at the Head Office of the State Railways at Brussels.

A number of members of the Local Commission of Organisation for the London Congress were present at the meeting, the vice-president, Mr. COLSON, being in the chair.

Tributes were paid to the memory of Mr. Gustave NOBLEMAIRE, a former member, and to Mr. Jules VERDEYEN, the general secretary of the Permanent Commission, who have died since the last meeting.

* * *

I. — The meeting proceeded to nominate, as members of the Permanent Commission, Messrs. MARCHAL, LAMALLE, JACQUES, MOLLE and GHILAIN (Belgium), Sir Henry FOWLER (Great Britain), Sir Ernest Albert Seymour BELL (India), Sir Henry Worth THORNTON (Canada) and Mr. IKEDA (Japan).

Mr. FOULON, general manager of the Belgian State Railways, was unanimously elected president of the Permanent Commission, in place of Mr. TONDELIER, who has resigned.

Mr. FOULON thanked the meeting and took his place as president.

Mr. MARCHAL, Head of a Department on the Belgian State Railways, was nominated as vice-president, and Mr. GHILAIN, chief engineer of the same railway, was appointed general secretary of the Permanent Commission, in place of Messrs. BRUNEEL, resigned, and VERDEYEN, deceased, respectively.

The composition of the Permanent Commission, as the result of these nominations, is shewn on the attached.

* * *

II. — The balance sheet for the year 1924, which had been certified by an auditor, and the estimated budget for the year 1925, were approved of.

This estimated budget has been drawn up, taking the variable part of the subscription paid by participating Administrations (article 17 of the statutes) in accordance with the rate adopted for the year 1924, that is to say, at 0.35 Belgian francs per kilometre.

⁂

III. — The Permanent Commission ratified the proposal of the English Railway Association to complete the Local Organising Committee for the London session.

The composition of this Committee is also attached.

⁂

IV. — A statement was made as to the present situation with regard to the reports on the questions included in the agenda for the tenth session.

Only a few reports are outstanding.

All necessary steps have been taken to have the reports printed and distributed to the delegates in good time.

The Permanent Commission have appointed the special reporters, whose duties are to lay before the sections a summary of the reports prepared on the same question.

⁂

V. — The programme for the session was definitely approved of; the Local Commission of Organisation have sent this to the delegates, together with a list of the principal hotels in London.

The Permanent Commission is, moreover, looking into various other questions as regards the organisation of the session.

⁂

VI. — The Commission has further examined — in continuation of the work commenced at its meeting held on the 5 July 1924 — various amendments to be made in the statutes of the Association.

The new statutes, as thus amended, will be put before the Association for approval at the General Meeting to be held at the London Congress.

⁂

VII. — The following alterations have taken place since the last meeting :

GOVERNMENTS.

The Irish Free State Government has joined the Association.

ADMINISTRATIONS.

Admissions :

	Km.	Miles.
Gold Coast Government Railways	537	334
Iraq State Railways	1 218	757
Ceylon Government Railways	1 181	734
East Indian Railways (State Railway)	4 463	2 773
Göteborg-Borås and Borås-Alfvesta Railway	261	162

Resignation :

Lima Railways	261	162

Alterations :

The four following Irish Companies :

1° Great Southern & Western Railway;

2° Midland Great Western Railway of Ireland;

3° Cork, Bandon & South Coast Railway;

4° Dublin & South Eastern Railway;

have been amalgamated under the name : « Great Southern Railways Company ».

The Railway Congress Association now consists of 236 Administrations whose lines comprise 478 700 km. (297 500 miles).

General Secretary,
P. GHILAIN.

President,
Edm. FOULON.

APPENDIX.

LIST OF MEMBERS OF THE PERMANENT COMMISSION

OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION.

President :

E. **Foulon** (3), administrateur-directeur général des chemins de fer de l'Etat belge; rue du Progrès, 74, Bruxelles.

Vice-presidents :

C. **Colson** (2), membre de l'Institut, inspecteur général des ponts et chaussées, vice-président du Conseil d'Etat de France; rue de Laplanche, 2, Paris;

Marchal (2), administrateur des chemins de fer de l'Etat belge; rue de Louvain, 21, Bruxelles.

Members of the Executive Committee :

G. **Behrens** (3), director, London Midland & Scottish Railway; Chepstow street, 20, Manchester;

The Right Hon. Sir Evelyn **Cecil** (1), G. B. E., M. P., privy councillor, director, Southern Railway; Cadogan Square, 2, London, S.W.1;

Griolet (3), vice-président du conseil d'administration de la Compagnie du chemin de fer du Nord français; avenue Henri Martin, 97, Paris.

Ex-president of session, member ex-officio :

R. DE **Cornè**, ingénieur, président du conseil supérieur des travaux publics d'Italie; Rome.

Members :

Belgium.

E. **Foulon** (already named);

Marchal (already named);

A. **Braem** (3), administrateur des chemins de fer de l'Etat; rue de Louvain, 17, Bruxelles;

U. **Lamalle** (2), administrateur des chemins de fer de l'Etat; rue de Louvain, 17, Bruxelles;

Jacques (1), administrateur des chemins de fer de l'Etat; rue de Louvain, 17, Bruxelles;

Molle (1), administrateur des chemins de fer de l'Etat; rue de Louvain, 17, Bruxelles;

H. **Caufriez** (1), directeur général de la Société nationale belge des chemins de fer vicinaux; rue de la Science, 14, Bruxelles;

G. **Philippe** (3), inspecteur général des lignes Nord belges; Liége;

P. **Ghilain** (2), ingénieur en chef, inspecteur de Direction aux chemins de fer de l'Etat, président de la Commission de réception du matériel et des approvisionnements; rue du Progrès, 74, Bruxelles.

China.

Tsang Ou (2), directeur général adjoint du chemin de fer du Lunghai; rue de Mogador, 5, Paris.

Denmark.

T. A. **Alstrup** (3), directeur général des chemins de fer de l'Etat; Gl. Kongevej, 1, Copenhague.

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(1) Retires at the 10th session.

(2) Retires at the 11th session.

(3) Retires at the 12th session.

Egypt.

Abdul-Hamid Pacha **Soliman** (2), directeur général des chemins de fer, télégraphes et téléphones de l'Etat; Le Caire.

Spain.

A. **Valenciano y Mazerès** (2), ingénieur en chef des ponts et chaussées, sous-directeur général des travaux publics et chef de la section des chemins de fer au Ministère du fomento; Calle de Piamonte, principal derecha, 14, Madrid;

Maristany (3), marquis de l'Argentera, directeur général de la Compagnie des chemins de fer de Madrid à Saragosse et à Alicante; Estación de Atocha, Madrid.

United States of America.

D. **Willard** (1), chairman of the Board, American Railway Association, president, Baltimore & Ohio Railroad; Baltimore, Md.;

R. H. **Aishton** (3), president, American Railway Association; South Dearborn Street, 431, Chicago, Ill.;

L. F. **Loree** (3), president, Delaware & Hudson Railroad; Nassau Street, 32, New York City;

W. W. **Atterbury** (1), vice-president, Pennsylvania Railroad System; Broad Street Station, Philadelphia, Pa.

France.

C. **Colson** (already named);

E. **du Castel** (2), conseiller d'Etat, directeur général honoraire des chemins de fer au Ministère des travaux publics; boulevard Saint-Germain, 241, Paris;

M. **Fontaneilles** (2), inspecteur général des ponts et chaussées, président de la section des chemins de fer au conseil général des ponts et chaussées; rue de Sèvres, 4, Paris;

P. **Riboud** (2), directeur de la Compagnie des chemins de fer de l'Est; rue d'Alsace, 21, Paris;

J. R. **Paul** (3), directeur de la Compagnie des chemins de fer du Midi; boulevard Haussmann, 54, Paris (IXe);

G. **Griolet** (already named);

J. B. **Javary** (1), directeur de l'exploitation de la Compagnie du chemin de fer du Nord; rue de Dunkerque, 18, Paris;

Margot (3), directeur général de la Compagnie des chemins de fer de Paris à Lyon et à la Méditerranée; rue Saint-Lazare, 88, Paris;

A. **Mange** (1), directeur de la Compagnie du chemin de fer de Paris à Orléans; rue de Londres, 8, Paris.

Great Britain.

J. R. **Brooke** (1), C. B., permanent secretary, Ministry of Transport; Whitehall Gardens, 6, London, S. W. 1;

The Right Hon. Viscount **Churchill** (1), G. C. V. O., chairman, Great Western Railway; Paddington Station, London, W. 2.;

G. **Behrens** (already named);

Sir Guy **Granet** (2), G. B. E., chairman, London Midland & Scottish Railway; Lombard Street, 80, London, E. C. 3;

The Right Hon. H. G. **Burgess** (2), general manager, London Midland & Scottish Railway; Euston Station, London, N. W. 1;

The Right Hon. Sir Evelyn **Cecil**, G. B. E., M. P. (already named);

Sir Francis **Dent** (3), C. V. O., director, Southern Railway; Porthyfelin, Holyhead;

Sir Henry **Fowler** (2), K. B. E., deputy chief mechanical engineer, London Midland & Scottish Railway; Derby.

Canada.

Sir Henry W. **Thornton** (3), chairman and president, Canadian National Railways; Montreal, Que.

India.

Sir Ernest Albert Seymour **Bell** (3), Kt., C. I. E., government director of the Indian Railway Companies; India Office, Whitehall, London, S. W. 1.

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(1) Retires at the 10th session.
(2) Retires at the 11th session.
(3) Retires at the 12th session.

Italy.

R. DE **Cornè** (already named);

Abdelcader **Fabris** (1), ingénieur, chef du service du matériel et de la traction des chemins de fer de l'Etat; villa Patrizi, Rome;

Felice **Fiori** (1), ingénieur, chef de service principal des chemins de fer de l'Etat; Rome;

Riccardo **Gioppo** (3), ingénieur, inspecteur supérieur à la Direction générale des chemins de fer de l'Etat; Rome;

F. **Tajani** (1), ingénieur, président de la Fédération des transports; via Nirone, 21, Milan.

Japan.

K. **Ikeda** (2), delegate of the Japanese Government Railways; Sentinel House, Southampton Row, London, W. C. 1.

Holland.

L. M. **Barnet Lyon** (3), ingénieur civil, membre du conseil de surveillance des chemins de fer; Statenlaan, 14, La Haye.

Poland.

A. **Frank** (1), ingénieur des ponts et chaussées, inspecteur au Ministère des chemins de fer; Varsovie.

Rumania.

C. **Mereutza** (2), sous-directeur général des chemins de fer roumains; Bucarest.

Sweden.

A. **Granholm** (2), directeur général des chemins de fer de l'Etat; Stockholm.

Switzerland.

Le Dr. R. **Herold** (1), directeur au département fédéral des postes et des chemins de fer; Berne;

Zingg (2), président de la direction générale des Chemins de fer fédéraux; Berne;

G. **Kunz** (1), directeur du chemin de fer Berne-Loetschberg-Simplon; Berne.

Czecho-Slovakia.

E. **Kejr** (3), ingénieur, conseiller des constructions du département V/1 au Ministère des chemins de fer; Prague.

Administrative Councillor : A. **Braem** (already named).

SECRETARY'S OFFICE : rue du Progrès, 74, Bruxelles.

General Secretary : P. **Ghilain** (already named).

Secretary-Treasurer : Ed. **Holemans,** inspecteur de direction honoraire des chemins de fer de l'Etat belge.

Assistant Secretary-Treasurer :

J. **Habran,** directeur d'administration honoraire des chemins de fer de l'Etat belge.

Assistant Secretaries :

R. **Desprets,** ingénieur principal aux chemins de fer de l'Etat belge;

E. **Minsart,** ingénieur principal aux chemins de fer de l'Etat belge, chef du Cabinet de M. le Ministre.

J. P. **Van Rijn,** ingénieur principal aux chemins de fer de l'Etat belge.

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(1) Retires at the 10th session.
(2) Retires at the 11th session.
(3) Retires at the 12th session.

Corrigenda

to report No. 1 on question III (Shunting yards) of the tenth session of the International Railway Congress Association, by W. Simon-Thomas.

Bulletin of February 1925 :

Page 270/III-118, 1st column, lines 6 to 9 from the top, *instead of:* « In this yard, the number of wagons derailed during shunting operations amounted to 14 °/₀ of the total number of wagons shunted », *read* : « In this yard, the number of wagons sent on a wrong road during the shunting operations amounted 14 °/₀ of the total number of wagons shunted ».

Page 298/III-146, 1st column, lines 7 and 8 from the bottom, *instead of :* « In that case, it is necessary that the warehouse ... », *read:* « If not so, it is necessary that the warehouse ... ».

Page 304/III-152, 2nd column, lines 6 to 15 from the top, *the 12th suggestion must be read as follows:* « At humps arranged with a single arrival track, a track adjacent to the hump, constructed on the level, may be used with advantage as a road on which the auxiliary locomotive used for pushing up the wagons on the shunting siding, may stand .»